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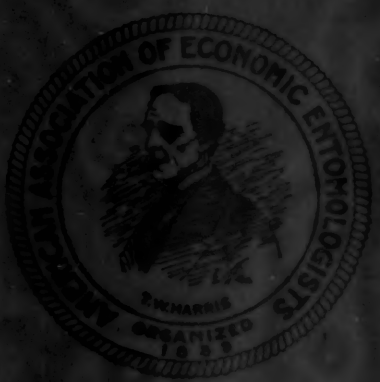

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[1] Paper not received. [2] Withdrawn for publication elsewhere. [3] Paper published elsewhere.

JOURNAL
OF
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VOL. 23 OCTOBER, 1930 No. 5

Proceedings of the Fifteenth Annual Meeting of the Pacific Slope Branch, American Association of Economic Entomologists

The 15th annual meeting of the Pacific Slope Branch was held at the University of Oregon—Eugene, Oregon—June 19 and 20, 1930. On Thursday the entomologists joined with the biologists for the annual dinner. On Friday afternoon there was an excursion to the Oregon State College and Experiment Station at Corvallis. The total attendance was 41, with the following members present:

L. P. Rockwood, Forest Grove, Ore.
W. V. King, Mound, La.
B. G. Thompson, Corvallis, Ore.
E. J. Newcomer, Yakima, Wash.
E. R. De Ong, San Francisco, Cal.
H. E. Burke, Palo Alto, Cal.
Trevor Kincaid, Seattle, Wash.
LeRoy Childs, Hood River, Ore.
A. J. Flebut, Berkeley, Cal.
Geo. M. List, Ft. Collins, Col.
Eugene S. Kellogg, Santa Barbara, Cal.
Anthony Spuler, Wenatchee, Wash.
Max M. Reeher, Forest Gr., Ore.
Joseph Wilcox, Corvallis, Ore.
T. R. Chamberlin, Forest Gr., Ore.
R. L. Webster, Pullman, Wash.
H. A. Scullen, Corvallis, Ore.
W. J. Chamberlin, Corvallis, Ore.
F. P. Keen, Portland, Ore.
Don C. Mote, Corvallis, Ore.
J. C. Elmore, Box 66, Garden Grove, Cal.

PART I.—BUSINESS PROCEEDINGS

The meeting was called to order by Chairman Don C. Mote, at 1:30 P. M. Thursday. J. C. Elmore served as acting secretary. The following committees were appointed: NOMINATING—Jos. Wilcox, R. L. Webster, F. P. Keen; RESOLUTIONS—E. J. Newcomer, G. M. List; AFFILIATION—L. P. Rockwood, H. E. Burke; AUDITING—W. J. Chamberlin.

REPORT OF THE TREASURER FOR 1930

Balance on hand June 20, 1929		$11.25
Interest		.52
Refund from Main Association		18.65
Paid out:		
Envelopes, registry and postage	$13.02	
Notices and title blanks	7.50	
Miscellaneous	2.50	
	$23.02	
Balance on hand June 20, 1930	$ 7.40	
	$30.42	$30.42

Chairman Mote read a proposal from E. O. Essig, for some years a member of the Affiliations Committee, proposing that a trial be given a winter meeting. After some discussion it was moved and carried unanimously that the Pacific Slope Branch hold but one meeting a year, to be held at the time and place of the meetings of the Pacific Division A.A.A.S.

FINAL BUSINESS SESSION

Chairman Mote called for the reports of Committees: The Nominating Committee presented the following names: Chairman, Roy E. Campbell; Vice-Chairman, H. E. Burke; Secretary-Treasurer, H. H. Scullen. The Resolutions Committee presented resolutions expressing appreciation to the University of Oregon for its hospitality; to Chairman Mote and Acting Secretary J. C. Elmore, for their efforts in arranging the meeting and program; and that if possible arrangements be made to send all members the printed program, whether members of the A.A.A.S. or not. The Auditing Committee reported the accounts of the Treasurer as correct. The Membership Committee presented 2 names for associate membership.

The reports of all the committees were accepted. On a vote of preference for time of meeting, the following was indicated: Summer—11, Winter—9, No preference—8. A motion was made and carried that hereafter we adhere to our custom of an entomologists dinner rather than combining with any other group.

It was announced that the 1931 meeting would be held in Pasadena, California.

PART II.—PAPERS AND DISCUSSIONS

Chairman Mote called the meeting to order at 2:30 P. M., and the following papers were presented:

FOOD CONSUMED BY THE CHINA PHEASANT IN OREGON

By Don C. Mote, T. A. Allen and Mrs. C. E. Chuster, *Oregon State Agr. College, Corvallis, Oregon.*

(Paper not received)

WHICH INSECTS ARE THE IMPORTANT ENEMIES OF SHADE, PARK, AND ORNAMENTAL TREES IN THE PACIFIC STATES?

By H. E. Burke, *Senior Entomologist, Division of Forest Insects, Bureau of Entomology*

Abstract

A list of 50 of the most important insect enemies of trees used for ornament, shade and park purposes in the Pacific States, ranked in importance according to information furnished by questionnaires sent to university, city, county, state and government men interested in insects.

Before we can conduct an intelligent campaign against the insect enemies of our trees in the Pacific States we must know the species we have to fight. In order to get this information in the quickest and easiest way possible and still with a reasonable degree of reliability, the writer, during April, 1929, sent out 105 questionnaires. These went to state entomologists, professors of entomology, directors of federal insect laboratories, superintendents of state highways, county horticultural commissioners, and superintendents of city parks in the states from Montana south to New Mexico and west to the Pacific. The questionnaire requested the correspondent to express his opinion on the relative importance of the insects injurious to trees in the area under his observation, and to note for each insect its distribution and principal host plants. Fifty-nine questionnaires were returned with the information desired.

The information furnished by the questionnaires returned, with that obtained by the writer and his associates during the past ten years, gives a very good general idea of the relative importance of the various species. It reveals what we know about their past importance, where they are important, and upon what species of trees they are important.

Ranking the insects, according to information obtained from the questionnaires, by giving the species marked first in importance a weight of ten for each time marked first and so on down to a weight of one each time marked tenth, we get a list showing the following species, weights, and relative ranks:

Rank	Weight	Species	
1	225	Red spiders	Probably several species
2	147	Pacific flathead borer	*Chrysobothris mali* Horn
3	146	European elm scale	*Gossyparia spuria* (Modeer)
4	126	Oyster-shell scale	*Lepidosaphes ulmi* (L.)
5	106	Mealybugs	*Pseudococcus* spp.
6	93	Black scale	*Saissetia oleae* (Bernard)
7	79	Elm leaf beetle	*Galerucella xanthomelaena* (Schrank)
8	78	Cypress bark beetle	*Phloeosinus cristatus* (Lec.)
9	77	Pacific oak twig girdler	*Agrilus angelicus* Horn
10	68	California oak worm	*Phryganidia californica* Pack.
11	65	Brown apricot scale	*Lecanium corni* Bouché
12	62	Green apple aphis	*Aphis pomi* DeGeer
13	50	Forest tent caterpillar	*Malacosoma disstria* Hbn.
14	47	Fall webworm	*Hyphantria cunea* (Drury)
15	33	Spruce gall aphis	*Adelges cooleyi* (Gill.)
16	29	Carpenter worm	*Prionoxystus robiniae* (Peck)
17	28	Pine leaf scale	*Chionaspis pinifoliae* (Fitch)
18	27	Pacific sycamore lace bug	*Corythucha confraterna* Gibson
19	26	Elm gall aphis	*Eriosoma americanum* (Riley)
20	21	Common flathead borer	*Chrysobothris femorata* Oliv.
21	20	Cottony maple scale	*Pulvinaria vitis* (L.)
22	20	Italian pear scale	*Diaspis piricola* (Del G.)
23	19	Western pine beetle	*Dendroctonus brevicomis* Lec.
24	19	Woolly elm-apple aphis	*Eriosoma lanigerum* (Hausmann)
25	16	Black Hills beetle	*Dendroctonus ponderosae* Hopk.
26	15	California tussock moth	*Hemerocampa vetusta* (Bvd.)
27	14	Willow leaf beetle	*Lina interrupta* (Fabr.)
28	13	Alder leaf beetle	*Haltica bimarginata* Say
29	12	Cottonwood leaf beetle	*Lina scripta* (Fabr.)
30	10	Hazel scale	*Lecanium coryli* (L.)
31	9	Turpentine beetle	*Dendroctonus valens* Lec.
32	9	Red scale	*Chrysomphalus aurantii* (Mask.)
33	9	Locust borer	*Cyllene robiniae* Forster
34	9	San Jose scale	*Aspidiotus perniciosus* Comstock
35	8	Grasshoppers	*Melanoplus* spp.
36	8	Satin moth	*Stilpnotia salicis* (L.)
37	8	Cottonwood leaf miner	*Proleucoptera albella* (Chambers)
38	8	Cottony cushion scale	*Icerya purchasi* Maskell
39	8	Douglas fir tussock moth	*Hemerocampa pseudotsugata* McD.
40	8	Box elder leaf roller	*Cacoecia semiferana* (Walker)
41	7	Willow scale	*Chionaspis salicis-nigrae* Walsh.
42	7	Greedy scale	*Aspidiotus camelliae* Sign.
43	7	Monterey pine engraver	*Ips* spp.
44	7	Black aphis	*Aphis rumicis* L.
45	6	Red-humped caterpillar	*Schizura concinna* (A. & S.)
46	5	Hemispherical scale	*Saissetia hemisphaerica* (Targ.)
47	3	Giant hardwood root borer	*Prionus californicus* Mots.
48	3	Oak gall defoliator	*Andricus bicornis* (McC. & Egb.)
49	3	Spiny elm caterpillar	*Aglais antiopa* (L.)
50	1	Hornet moth	*Alcathoe apiformis* (Clerck)

Half of the species appear to be introduced and half are natives. Of the first ten, the third, fourth, fifth, sixth, and seventh are introduced and the second, eighth, ninth and tenth are native.

Taking the area as a whole and the period of time as the past twenty years, the list undoubtedly gives a good general idea of the relative importance of the insect pests of our Pacific coast shade trees. For any one area or any one time, however, it does not hold. For instance, this season at Palo Alto we have received more inquiries about two small moth caterpillars which defoliate cypress than about any of the species on this list. One of these, *Argyresthia franciscella* Busck, is known, and the other, a leaf tier, appears to be unknown. Aphids may be very important in a moist climate like that of western Oregon and western Washington, and of no importance in a hot dry climate like that of southern California. On the other hand, red spiders may be important where the climate is dry and not so important where it is moist, or important during a dry season and unimportant during a wet one.

Much depends also upon the varieties of trees grown in the area under consideration. Certain scale insects which live only on subtropical plants may be very important in southern California and of absolutely no consequence in Montana, where neither they nor their host plants occur. The cottonwood leaf miner is important in Wyoming and Utah, where the cottonwood is an important tree, and unimportant in other areas where the cottonwood is little used.

About the only conclusion that it is safe to draw is that practically everywhere, with almost every species of planted or native tree, sooner or later some pest will cause serious injury. This season it may be one species, next season another. As climatic or other conditions change, native insects of which we know little become important, or immigrants come in and cause us the most trouble. Ten years ago we did not expect to be fighting our native Douglas fir tussock moth, Yellowstone sawfly, and spruce budworm, or the introduced elm leaf beetle, satin moth, and hazel scale. Tree lovers must be made to realize that if they would have satisfactory ornamental, shade, and recreational trees, they must spend a reasonable amount practically every year in fighting insect pests.

CORRELATION OF TEMPERATURES WITH HOST PLANT DEVELOPMENT AND DEGREE OF INFESTATION OF THE PEPPER WEEVIL, *ANTHONOMUS EUGENII* CANO, IN CALIFORNIA

By J. C. Elmore, *U. S. Bureau of Entomology*

(Paper not received)

DISTRIBUTION OF TWO SPECIES OF EPITRIX (COLEOPTERA) IN WASHINGTON

By R. L. Webster, *Washington State Agricultural College*

(Paper not received)

NOTES ON THE DISTRIBUTION AND ALTITUDE RANGE OF OREGON BREMIDAE (HYMENOPTERA)

By H. A. Scullen, *Oregon State Agricultural College*

Abstract

Twenty-two species and 15 varieties of *Bremus*, four species and one variety of *Psithyrus* have been taken in the state. Bumblebees range from sea level to the snow line, and are common in all parts of the state except the arid uncultivated sections. Several species are of considerable value in the red clover districts for pollenization purposes.

During the past eight years the writer has been collecting and studying bumblebees throughout most parts of the state of Oregon. These studies of Oregon bumblebees have been made, first, to determine what species we have present in the state, their geographical distribution and altitudinal range, together with their flora visiting habits. Secondly, we have been interested in studying them because of their value in the pollenization of certain commercial crops, especially that of red clover. So far twenty-two species and fifteen varieties of *Bremus* and four species and one variety of *Psithyrus* have been taken in Oregon.

Bumblebees can usually be found in abundance from sea level to the snow line on the higher mountains. Along the Oregon coast region and in the Coast mountains *B. vosnesenskii* (Rad.) and *B. mixtus* (Cr.) are abundant. Passing over into the Willamette Valley section where red clover is an important field crop *B. californicus* (Sm.) is probably the most important species. However, *B. mixtus* (Cr.) is also very abundant. *B. vosnesenskii* (Rad.) and *B. occidentalis* (Green) are

common. In the Coast Mountains *B. mixtus* (Cr.) and *B. vosnesenskii* (Rad.) are the more common in the lower sections of the mountains, while as we approach the higher altitudes in the coast mountains *B. melanopygus* (Nyl.) appears to be the more common. As we pass up into the foothills of the Cascades we find *B. occidentalis* (Green) becomes more and more common and at an elevation of 4000 to 5000 feet it is very abundant on the alpine flora. Associated with it and in equal numbers is *B. bifarius nearticus* (Hand.). As we go on up toward the snow line approaching 6000 feet and over *B. sylvicola* (Kirby) becomes the more common form.

Throughout the central desert region of eastern Oregon bumblebees are not common, but as we approach the mountains of eastern Oregon, they once more become abundant.

In the valleys of northeastern Oregon *B. hungii* (Green) becomes the more common although *B. falvifrons* (Cr.) and *B. occidentalis* (Green) are not at all uncommon. As one goes higher in the Blue Mountains *B. occidentalis* (Green) becomes far more common and at elevations up to 7000 feet is the most abundant. As one gets still higher and approaches the snow line, *B. sylvicola* (Kirby) begins to appear common.

The bumblebees have long been recognized as of great economic value in the pollenization of important agricultural plants. Outstanding among these is red clover, *Trifolium pratense* L. The role of bumblebees in the production of red clover seed has been studied by numerous investigators but more recently by Westgate and Coe (1915). These authors state (1915 p. 18): "Repeated field observations in Iowa in 1911 and 1912 showed that bumblebees were actively engaged in collecting nectar from eight to nine hours a day. Little work was done by them before the dew had entirely disappeared from the foliage and flowers or after six o'clock in the evening. Observations showed that bumblebees are able to pollinate 30 to 35 flowers a minute. However, they seldom visit more than eight to ten in a single head at one time." These same writers state (page 27) that in dry years "The honey bee proved to be as efficient a cross pollenator of red clover as the bumblebees— ."

The value of the annual red clover seed crop in Oregon is estimated at $500,000 by the Farm Crops Department of the Oregon State Agricultural College.

Bumblebees assist in the pollenization of other clovers, but as these are usually freely visited by the honey bee, the bumblebee is far less important than is true with the red clover. As a pollenizer of tree fruits, the bumblebee is of minor importance. The honey bee or even the

smaller *Andrenidae* and *Halictidae* are probably more frequent visitors. The work of Rawes and Wilson (1922, p. 16 and 17) in England, indicates that possibly bumblebees have not been given as much credit as they deserve for pollenization of apples. These writers state that bumblebees were "very important pollinators, keeping active in all kinds of weather, a few individuals having been observed at work during a snow squall."

If we were to suggest one species which might be encouraged and increased to assist in the pollination of the red clover crop of the Willamette Valley, this species would probably be *B. californicus* (Smith). Some effort has been made to get our native bumblebees to nest in artificial nests as described by Frison of Illinois, but with practically no success. A few nests of *B. californicus* (Smith) have been found above ground in old rags, etc. This would suggest a possible type of artificial nest which might prove attractive to them.

Observations so far seem to indicate that there is considerable variation from one year to another in the number of bumblebees available. The value of the red clover seed crop of the Willamette Valley would justify some effort in trying to work out some satisfactory means of providing an ample supply of pollenizing agents in the way of either bumblebees or longer tongued honey bees.

The writer is deeply indebted to Dr. Theodore H. Frison of the Illinois Natural History Survey for his assistance in determining most of the bumblebees collected in the state.

ALTITUDE RANGE AND DISTRIBUTION OF OREGON *Bremidae*

Bremus	Coast region	Cascades	East. Oregon
B. nevidensis (Cresson)	Rare		Uncommon 4,000 ft.
B. separatus (Cresson)	Uncommon		Uncommon 4,000 ft.
B. morrisoni (Cresson)	Uncommon		Uncommon 4,000 ft.
B. rufocinctus (Cresson)			Rare 2–4,000 ft.
B. rufocinctus iridis (Ckll. & Porter)			Very rare 4,000 ft.
B. rufocinctus prunellae (Ckll. & Porter)			Very rare 4,000 ft.
B. kirbyellus (Curtis)		8,000 ft.	
B. occidentalis (Green)	Common All elevations	Abundant To 5,000 ft.	Common 4–7,000 ft.
B. occidentalis proximus (Cresson)	Rare	Rare	Rare
B. franklini Frison	2 specimens 500 ft.		
B. huntii (Green)	Very rare		Very common 2–4,000 ft.

B. huntii rufosuffusus (Ckll.)			Very rare
B. edwardsii (Cresson)	Very rare		
B. edwardsii russulus Frison		Very rare	
B. vosnesenskii (Redoszkowski)	Very abundant All elevations	Common to Rare	
B. bifarius (Cresson)			Steans Mts. Rare 7,000 ft.
B. bifarius vancouverensis (Cresson)			Steans Mts. Rare 7,000 ft.
B. bifarius kenoyeri (Ckll.)			Steans Mts. Rare 7,000 ft.
B. bifarius nearticus (Handl.)		Abundant 4–5,000 ft.	Common 4–7,000 ft.
B. sylvicola (Kirby)		Rare 6,000 ft.	
B. sylvicola sculleni Frison			Uncommon 7,000 ft.
B. melanopygus (Nylander)	Common 0–3,000 ft.	Uncommon	Uncommon
B. melanopygus washingtonensis Frison		Mt. Hood 6,000 ft.	
B. sitkensis (Nylander)	Uncommon	Rare	Rare
B. caliginosus Frison	Rare		
B. mixtus (Cresson)	Abundant 0–4,000 ft.	Common to 4,000 ft.	Common
B. frigidus (Smith)	Rare		
B. flavifrons (Cresson)			Rare
B. flavifrons dimidiatus (Ashmead)	Rare	Rare	Rare
B. flavifrons ambiguus (Franklin)		Rare	
B. flavifrons vandykei Frison		Rare	
B. centralis (Cresson)			Common 4,000 ft.
B. appositus (Cresson)	Common 100–500 ft.	Rare	Common 1,000–4,000 ft.
B. fervidus (Fabricius)	Uncommon		Common 1,000–4,000 ft.
B. californicus (Smith)	Very abundant 0–4,000 ft.	Rare	Rare
B. californicus consanguineus (Handl.)	Rare	Rare	Rare
B. californicus dubius (Cresson)	Rare	Rare	Rare
Psithyrus			
P. insularis Smith	Uncommon	Rare	Uncommon
P. crawfordi Franklin	Uncommon	Rare	
P. suckleyi Green	Rare	Common 4,000 ft.	Rare
P. fernaldae Franklin	Uncommon		
P. fernaldae wheeleri (Bequaert and Plath)	Rare	Rare	

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Rawes, A. B. and Wilson, G. F. 1912. "Pollination in Orchards. VI. Pollen-carrying Agents." Jour. Roy. Hort. Soc., 47, No. 1; 15–17. (1912).

Westgate, J. N. and Coe, H. S. 1915. "Red Clover Seed Production: Pollination Studies." U. S. Dep. of Agric., Bull. 289.

NOTES ON THE INTRODUCTION OF THE WOOLLY APPLE APHIS PARASITE, *APHELINUS MALI*.

By LEROY CHILDS and D. G. GILLESPIE, *Hood River Experiment Station, Hood River, Oregon*

ABSTRACT

A survey of the apple districts of the Pacific Coast indicates that with one exception the woolly apple aphis parasite, *Aphelinus mali*, is non-existent or, at least, occurs in such small numbers no authenic records have been made with reference to its association with the woolly apple aphis. The insect occurs in limited areas at Vancouver, B. C., apparently the result of liberations made by R. C. Treherne in 1922.

The parasite was first introduced into the Hood River Valley in the late summer of 1928 from Fenville, Michigan. Other material was received from this area during 1929. The parasite has successfully passed two winters in the field and has thoroughly established itself at a number of points as a result of liberations made during the summer of 1929.

A complete life history is being made of the parasite. Seven generations of the insects occurred during 1929. It is still too early to predict to what extent Aphelinus will influence the control of the woolly apple aphis, it offers at least much promise as a factor along this line.

In view of the fact that demonstrations have shown the woolly apple aphis, *Eriosoma lanigera* (Hausman) to be definitely associated with the spread of perennial canker *Gloeosporium perennans* Zeller and Childs,[1] the suppression of the woolly apple aphis appears to be the key to successful canker control.

The woolly apple aphis does not respond well to control measures applied in the form of sprays due largely to the fact that it is an insect which seeks out areas more or less protected by overhanging bark. Where sprays are applied the insects survive in sufficient numbers to produce reinfestation of sprayed trees in a relatively short time even though exposed aphis have been effectively destroyed. Where canker diseases are present on apple trees the protected calluses upon which the woolly aphis is more inclined to feed are greatly increased and the problem of control is very definitely aggravated due to the protection offered. Large numbers of spraying tests and observations made where various types of contact insecticides have been used have demonstrated that the insects cannot be reached by known spray applications where they are located under overhanging bark areas.

In view of the fact that definite success has been obtained in the use of *Aphelinus mali*, the woolly apple aphis parasite, in Australia and New

[1]The Relation of Woolly Apple Aphis to Perennial Canker Infection with other Notes on the Diseases. Leroy Childs, Ore. Sta. Bul. No. 243, 1929.

Zealand following its introduction from the Eastern United States several years ago, an investigation of this insect was started in the summer of 1928 at which time the first parasites were introduced into the Hood River Valley from Fenville, Michigan.

DISTRIBUTION—WESTERN AMERICA. The senior author has been studying the relationship of the woolly apple aphis to perennial canker infection since 1924. Beginning with that year and extending up to the present time, practically all of the major apple sections of the Pacific Coast have been surveyed not only for the purpose of determining the range of canker infection but also for the purpose of observing the possible relationship of the aphis to canker infection.

This survey includes the following areas:—

BRITISH COLUMBIA:
Western British Columbia
Okanagan district

WASHINGTON:
Western Washington
White Salmon Valley
Wenatchee
Yakima

OREGON:
Hood River Valley
The Dalles-Mosier district
Grande Rounde Valley
Willamette Valley
Rogue River district in Southern Oregon

CALIFORNIA:
Yucapti
Watsonville

In California several other minor localities have been examined along the highway from the northern boundary to the southern boundary where apple trees are grown. Several apple districts of Idaho and Montana have also been examined. The results of this survey indicate that *Aphelinus mali* does not occur in the apple districts of the Pacific Coast,[2] with one exception where E. P. Venables, in correspondence, states that he has found the parasite in a limited area in the vicinity of Vancouver, B. C., established apparently as the result of introductions made by Treherne in 1922. The presence of the parasite is easily detected on aphis infested apple trees. The black shells of the destroyed aphids persist for long periods of time and can be confused with no other condition. These persistent, black shells show the conspicuous exit holes of the parasite. As a result of our observations it would seem that reports of the occurrence of this parasite on the Pacific Coast are erroneous or at least to the effect that the insect's occurrence is extremely rare. The rapid increase the parasite has made at points of liberation in our study of the insects' behavior seem to substantiate the fact that it has not been present or its occurrence would have been

[2]Insects of Western North America, E. O. Essig, pg. 828.

definitely recorded. Concerning this point, Professor Essig writes as follows: "So far as I know this insect does not occur in California, although the insectary men and the specialists in the Bureau have indicated to me that the insect probably occurs throughout the range of its host. If it does occur in this state I have never seen either the insect or evidences of its work. I have done a good deal of work on woolly aphis in this region during the past ten years and have been on the lookout for the parasite but have failed to locate it. If here, it is in exceedingly small numbers."

With the exception of the area of occurrence reported by Venables, Colorado seems to be the western limits of *Aphelinus mali;* though at this time even this record appears questionable due to the fact that both Professors Gillette and List have for a long time been associated with insect control problems on apple and have never observed the parasite or its work in connection with the woolly aphis. Professor Gillette expresses the following in correspondence: "I do not find that we have any data at all concerning its attacking this aphid (woolly aphis). Our only notes concerning it are in connection with the melon louse, *Aphis gossypii.*" In a number of instances records of the occurrence of *Aphelinus mali* have been associated with aphids other than the woolly aphis as in the case of the Colorado record. Many of these records are doubtless due to faulty determination of the insect involved. Where careful breeding tests have been made with *Aphelinus* with a number of aphis species other than the woolly aphis no parasitism has been found to occur. The writers have attempted parasitism with a number of species reported as susceptible to attack but with negative results. At the present time Dr. Howard[3] is of the opinion that *Aphelinus mali* does not attack aphis other than those with waxy coverings. Additional study will doubtless further limit this generalization. At the present time the writers' very much question the occurrence of this species in Western America in areas other than the single instance cited. Negative reports have been received from entomologists located in New Mexico, Arizona, Washington, Idaho, Nevada and Montana.

Introduction of Parasite into Hood River. The parasite was first established in Hood River from collections made in Michigan by the senior author in August, 1928. The insects were placed in cages of the character used by Lundie[4] along with further material gathered in

[3]Howard, Dr. L. O. *Aphelinus mali* and its travels. Annals Ent. Soc. No. 3, Sept. 1929.

[4]Lundie, A. E. A Biological Study of Aphelinus Mali Hald. A Parasite of the Woolly Apple Aphid, Eriosoma Lanigera Hausm. Memoir No. 79 Cornell University.

Michigan by Mr. L. G. Gentner of the Michigan State College. Some reproduction resulted from the activities of the parasites, but for the most part, due to the advanced season, emergence from parasitized aphids did not take place. The parasites caged on apple trees in the orchard successfully survived the winter of 1928 which, however, was of rather mild character. From this material and further material, generously supplied by Mr. Gentner from time to time throughout the spring and summer of 1929, local colonies were built up to the point where field liberations could be made shortly after the first of July, 1929. From twenty-five to fifty parasites were liberated on apple trees well infested with the woolly aphis. The liberated insects at once began their egg-laying within the bodies of the aphis. On a tree where liberations were made July 5th parasites were observed emerging from aphids twenty days later. The parasites continued active during the remainder of the summer though it was observed that the period occurring from egg to adult very materially increased as the summer advanced. That the adult parasites remain active late in the fall is indicated by the fact that an adult was observed "stinging" an aphid as late as October 22, 1929. A check-up of the condition of aphid colonies was made in the experimental orchard late in the fall. Parasitized aphids were found at distances as great as twelve tree rows from the point of liberation; greatest advance was made in the direction of prevailing winds. At the present time, June 15th, 1930, parasites can be found at least twenty-five tree rows away from point of original liberation.

It is still too early to predict to what extent the parasite will play in the economy of the woolly aphis. In view of the fact the insect has successfully survived two winters in the field in the Hood River district (1929 reaching -19.5°) it is reasonable to suppose that temperature factors will not prove to be limiting ones. It appears promising in view of the fact that we observed the occurrence of approximately seven generations during the season of 1928 and the insect is now (June 14th) in its third generation. The parasite is not a prolific reproducer—on the other hand its most encouraging behavior is that of early emergence. The adult parasites were first observed on the trees in the orchard April 20, 1930, at a time when the first aphis activity was noted. This behavior enables the parasite to at least start off at "scratch" with its highly reproductive host.

From a biological standpoint it seems strange indeed, that *Aphelinus* had not long since been thoroughly established on the Pacific Coast unless some unknown ecological factors have been in operation to prevent its establishment and which will, in turn, perhaps prevent the

successful use of the insect through introduction. It is very difficult to account for the fact that the parasite was not introduced along with its host on apple stocks from Eastern United States. As a result of its overwintering habit within the body of its host—usually tightly attached to the plant—it would appear that natural transportation and introduction would have been easily accomplished not only once but many times. This does not seem to have been the case as our survey has shown. The ease with which we have thus far established the insect in the field tends to dispel our fears and it will now be necessary to wait until the species reaches saturation before its effectiveness can be expressed.

Friday morning session

The meeting was called to order at 9:30 A. M. by Chairman Mote, and the following papers presented:

A SEED CATERPILLAR ON A NATIVE CLOVER IN THE NORTH PACIFIC REGION (*GRAPHOLITHA CONVERSANS*)

By L. P. Rockwood and Sadie E. Keen, *U. S. Bureau of Entomology*

(Withdrawn for publication elsewhere)

NOTES ON THE DISTRIBUTION AND SPREAD OF THE DUSKY-VEINED WALNUT APHIS, *CALLIPTERUS JUGLANDIS* FRISCH., IN OREGON

B. G. Thompson, *Oregon State Agricultural College*

(Paper not received)

NOTES ON LABORATORY METHODS IN TEACHING ENTOMOLOGY

By Roland E. Demmick, *Oregon State Agricultural College*

(Paper not received)

ENTOMOLOGY AND THE ENGINEERS

By W. J. CHAMBERLIN, *Forest Entomologist, Oregon State College*

ABSTRACT

Data relating to wood defects caused by insects has been collected in the belief that such information would be of particular value to engineers, especially as the major loss develops in the manufactured or utilized wood rather than in the forest.

Of recent years so many inquiries have been received requesting information relative to damage inflicted by insects or their near relatives to timber, and timber products, that a course dealing with such groups is being offered at Oregon State College.

It is felt that the prospective forester or logging engineer might soon be so situated that he would be able to prevent considerable loss to employers by having information relative to such damage at hand. The structural and the highway engineer in their use of timber, the electrical engineer in handling poles, and other construction material, those concerned with ships, ship building and marine constructions and the architect may at any time be confronted with problems which call for a knowledge of particular groups of insects or near relatives, how they work and what may be done in the way of prevention and control.

An effort has therefore been made to collect all possible data pertaining to defects in wood caused by insects as well as injury to metals and other materials, and to incorporate this information so it might serve as a guide in the class room and the field.

Realizing that the engineer is not particularly interested in the animals themselves, no great amount of space has been devoted to the purely entomological side. A few pages of introduction to insects, their structure and general habits are given together with ample references where those interested may obtain further information.

The work of the author in connection with the various forest insect problems in the northwest for more than 15 years has been supplemented by consulting all available sources of information to gather the material. As would be expected, the publications of the department of Agriculture, Bureau of Entomology have furnished the main source of information, but state bulletins, entomological serials, trade papers and to some extent text books have been consulted and to all these thanks are due and acknowledgment is usually given in foot notes throughout the pages.

Ordinarily one does not associate engineering with any phase of entomology, yet engineers are constantly coming in contact with problems where the service and advice of the trained entomologist must

be procured unless special training along these lines has been obtained by the engineer.

To cite a few examples of where such training is of value we might point to the extensive damage wrought by termites to all classes of structural timbers in buildings, bridges, wharves, foundation and especially to poles. In fact, in the southern portions of the United States and in our Island possessions, as well as in most all tropical parts of the world, the damage inflicted by termites constitutes one of the major problems of the engineers.

In California a termite investigation committee, consisting of entomologists, zoologists, chemical and consulting engineers, together with representatives of such industries as railroad, lumber, telephone, oil, gas and electric companies, has been working since 1928 studying the extensive damage of these pests and attempting to work out suitable methods of practical control.

A large group of beetles, popularly known as powder post beetles, causes losses aggregating hundreds of thousands of dollars each year. These beetles not only attack native trees but commonly work in rough and finished products, even where materials have been placed in buildings. Cases of floors and roofs falling with resulting loss of life are not unknown. Some very interesting engineering feats have been performed in repairing and replacing materials destroyed by these insects. Much may be done to prevent this type of loss if those in charge possess the requisite knowledge.

Telephone engineers have been baffled by the work of a tiny beetle in California which amuses itself by boring through the lead sheathing of telephone cables. This work short circuits the lines in wet weather and results in interruption of service and entails expensive repairs.

The logging engineer should be conversant with the type and extent of damage to living, dying and recently dead trees; how damage may be prevented to saw logs; how long logs may be left in the woods without suffering too great an amount of deterioration; what insects attack piled lumber, to what extent, and how may this be prevented.

Near relatives of insects also cause a tremendous loss. A problem which many engineers have had to face was how may piling be protected from marine borers. These enemies in the sea, while not true insects, work in a manner similar to the latter and cause an enormous loss each year.

True there are many problems of the engineer and entomologist which still remain unsolved, but the former must have at least some knowledge of insects, what they are, how they live and work in order to intelligently attack problems where insects are concerned.

Attention will be given the principal types of defects in timber and timber products; a survey of the insects and near relatives causing such damage, and possible means of prevention or control.

AMOUNT OF LOSS IN FOREST PRODUCTS CAUSED BY INSECTS AND THEIR NEAR RELATIVES. Various estimates have been made of the amount of damage caused to forests and forest products by insects and allied forms of life.

This loss is extremely difficult to arrive at, with any great degree of accuracy, but if error has been made it is probable that it is in being too conservative. The lowest careful estimate is set at $150,000,000 each year. This loss is by no means confined to the class of material in which the engineer is interested. However, it is safe to say that fully one-third of the amount, or $50,000,000 would be a fair value of the loss inflicted on the products in which we are interested.

Losses in finished products are more expensive than to living trees in the forest. To illustrate: Bark beetles may kill a fine young Douglas fir tree and the loss is merely a few hundred feet of timber valued at say $3.00 per thousand feet on the stump. On the other hand, a similar tree is selected as suitable for a power line pole, it is cut, peeled, transported to the railroad, hauled possibly hundreds of miles and finally set in place, the power lines are affixed and it is serving a useful purpose. This pole no longer represents merely a nominal value of a few dollars, but to its original cost must be added the cost of harvesting, transporting and placing it in its ultimate position. It may now be attacked and in a very few months destroyed by termites, so that the company not only loses this pole but is forced to replace it at added expense.

From this example it may be seen that the destruction by one group of insects may be of little consequence in the forest, but if that same piece of material be destroyed after it has reached its ultimate destination, the loss is likely to be ten times as much in actual dollars and cents.

Damage by insects often goes unnoticed in the woods; especially is this true of certain groups which work in the heart wood of living trees, leaving little evidence of their work on the exterior surface. Such trees may be cut, transported to the mill and started through before the defects are discovered and they have to be discarded.

With proper training it is often possible to detect the greater portion of these trees in the woods and save a considerable sum for the operator by recognizing the damage early and avoid allowing the material to continue on through the various phases of manufacture.

Damage by insects to living trees cannot ordinarily be prevented, but from the time a tree is felled and cut into logs, it becomes increasingly

attractive to insects and from this point on practically all types of damage are preventable by various means which will be discussed in detail later.

Defects do not always necessitate the discarding of the whole material as worthless. Very often wood unfit for specialized uses may be employed for some other purpose where the requirements are not so exacting. All such material should be used when possible in order to avoid waste. Closer utilization of wood is an urgent need in the industries today in order that our diminishing supply of timber of all kinds may be made to hold out as long as possible.

Losses inflicted by marine borers (which are not insects) are not included in the $50,000,000 mentioned above. No very thorough survey of the damage by these creatures has been made for the whole country but statements made by reputable engineers and others for given localities serve to throw some light on the subject. As far back as 1896 an engineer of unquestioned standing, stated that the loss in the harbor at San Francisco alone was no less than $250,000. The Committee of the Marine Piling Survey Commission places the loss in the San Francisco Bay region during 1920–21 at more than $15,000,000.

The borers are active not alone in the San Francisco Bay region, but are reported from Sitka, Alaska, to San Diego, California on the Pacific Coast, and are also quite destructive in the harbors of the Atlantic States and in the Gulf of Mexico.

EXPERIMENTS IN KILLING EGGS OF THE CODLING MOTH ON HARVESTED FRUIT

By E. J. Newcomer, *Senior Entomologist, U. S. Bureau of Entomology*

Abstract

Codling moth eggs occurring on canning pears or early apples often hatch after the fruit is picked and sorted. The larvae from these eggs cause considerable injury to the fruit while it is ripening. It is not practicable to kill the eggs by means of cold storage, since it is usually desirable that the fruit ripen as rapidly as possible. Washing the fruit for removal of spray residue does not harm the eggs, but a treatment with dilute oil emulsion in a machine used for residue removal kills the eggs without retarding the ripening of the fruit or affecting its quality.

Codling moth eggs frequently occur on apples and pears when they are harvested, especially on summer or fall varieties, such as Yellow Transparent or Jonathan apples and Bartlett pears. This fruit is often kept at fairly warm temperatures for a time after harvesting. In particular, pears for canning are usually held at ordinary temperatures

in order to ripen them. During this time the eggs of the codling moth hatch and the larvae enter the fruit. As a result, fruit that is not more than 3 or 4 per cent wormy when picked may be 20 per cent wormy by the time it is ready for canning. An investigation was made in the Yakima Valley of Washington for the purpose of finding a means of preventing losses from this cause.

The possibility of killing the eggs with cold was first investigated. It is well known that cool temperatures greatly retard the development of codling moth eggs, and that the incubation period, which may be only five or six days in hot weather, may be increased to as much as three weeks by low temperatures.[1] Since the eggs are normally deposited only during mild weather, it was thought that they might be killed easily by chilling. In a preliminary test, apples upon which eggs had been deposited were immersed in a mixture of ice and water and held at a temperature of 36° F. for two hours. This had no significant effect on the hatching of the eggs, 14 per cent of them failing to hatch as compared with 10 per cent in a check lot held for a like period in water at 70°F.

Tests were then made by placing apples bearing eggs in various rooms of a cold-storage plant. As this plant was in use, and fruit was being carried in and out of the cold rooms at intervals, the temperatures varied somewhat. However, by means of thermographs, records of the actual temperatures were obtained. It is thought that the conditions of the experiment were similar to those that would obtain in commercial cold storage.

Eggs were held at temperatures of 35° to 38°F. and at 26° to 33°F. for one and two days; and at temperatures of 27° to 33° for one, two, three, and five days. The results of these experiments are given in Table 1.

While these experiments do not show the actual degree of cold necessary to kill all of the eggs, they do show that the use of cold storage is not feasible as a means of killing the eggs on cannery fruit. It seems probable that the fruit would have to be held in storage at the minimum temperature it would stand, that is 30° F.,[2] for at least ten days or two weeks in order to kill all of the eggs. This could not be done on account of the delay in ripening and the expense. In the case of packed or loose

[1]E. J. Newcomer and W. D. Whitcomb. Life History of the Codling Moth in the Yakima Valley of Washington. U. S. Dept. Agric. Bul. 1235, 1924. Table 30, p. 33.

[2]According to Wright and Taylor (The Freezing Temperatures of Some Fruits, Vegetables, and Cut Flowers, U. S. D. A. Bul. 1133) Bartlett pears and most varieties of apples will freeze between 28° and 30° F.

fruit going into cold storage for later consumption, there should be no trouble with infestation by larvae hatching from eggs on the fruit at the time it is picked.

From a scientific standpoint, it is very interesting that codling moth eggs will actually survive subfreezing temperatures for more than 100

TABLE 1. EFFECT OF COLD ON CODLING MOTH EGGS, YAKIMA, WASH., 1928

No.	Temperature °F.	Number of days	Total eggs	Number dead	Per cent dead	Number of larvae that entered fruit	Per cent of total eggs producing larvae entering fruit
1	36–38.....	1	363	82	22.6	184	50.7
2	35–38.....	2	325	49	15.1	176	54.2
3	26–30.....	1	246	66	26.8	127	51.6
4	26–30 (32 hours) 33 (16 hours)	2	239	61	25.5	113	47.3
5	27–31.....	1	250	41	16.4	139	55.6
6	27–31.....	2	235	65	27.7	108	46.0
7	27–30 (56 hours) 33 (16 hours)	3	298	130	43.6	95	31.9
8	26 (48 hours) 27–30 (56 hours) 33 (16 hours)	5	391	196	50.1	128	32.7
9	Check — normal temperature..		153	16	10.5	103	67.3

hours, as they did in experiment 8. There is a popular notion that frosty mornings will kill the eggs of the codling moth, but unless extremely cold temperatures are experienced on these mornings, apparently no such effect would be produced.

Since equipment is now available for mechanically and chemically washing fruit for the removal of spray residue, an experiment was made to determine whether this treatment could be used for killing the eggs of the codling moth that might be on harvested fruit.

Apples carrying eggs were washed by the two methods in most common use. In both of these methods the fruit is passed through a machine on a rod conveyor, being sprayed very thoroughly with the washing solution from above and below by means of a series of fan-shaped diffused sprays. The fruit is then conveyed through a similar spray of water. In one of these tests, a commercial alkaline solution, composed of a mixture of borax and sodium carbonate, was used at the rate of three-fourths pound to 1 gallon of water, and at a temperature of 110° F. The fruit was in the bath for 27 seconds, and was rinsed for 9 seconds. In the other test, a standard 0.67 per cent solution of hydrochloric acid was used at a temperature of 70° F., the fruit being in the

bath and rinse for 55 seconds. A slightly higher percentage of eggs failed to hatch on both lots of washed fruit as compared with eggs on unwashed fruit. Possibly this was due to injuries sustained in handling the apples. However, from two-thirds to three-fourths of the eggs on the washed apples produced larvae which later entered the fruit. The treatment was therefore of no value.

Attention was then given to the use of oil emulsion, such as is employed for spraying fruit trees, in one of these machines. Through the cooperation of the Oregon Packing Co., a quantity of Bartlett pears was run through a standard fruit-washing machine holding 200 gallons of oil emulsion. The pears were carried through the machine on a rod conveyor and were sprayed very thoroughly from above and below with the emulsion. They were not rinsed or dried, but were carried immediately to lug boxes. It took approximately one minute for individual pears to pass through the machine.

Three summer oil emulsions, containing light, medium, and heavy oil, respectively, and one dormant oil emulsion were tested. These emulsions contained approximately 83 per cent of oil and they were tested at various strengths, with and without casein spreader, as shown in Table 2. Fruit carrying codling moth eggs was treated in six of the ten tests. In the five tests of summer oil emulsions (Nos. 1, 3, 4, 7 and 8) none of the eggs hatched; in the test with dormant oil emulsion 96 per cent of the eggs failed to hatch; whereas in the check only 11.2 per cent of the eggs failed to hatch. No observations were made on eggs in the tests where casein spreader was added, but data previously acquired, which have not yet been published, show that the addition of casein spreader to an oil emulsion has no appreciable effect on its ovicidal value. Evidently any of these emulsions may be used in this manner, without spreader, at the rate of 1 gallon of emulsion to 100 gallons of water (0.8 per cent actual oil) to kill codling moth eggs.

In order to find out whether the oil emulsion would in any way affect the quality of the pears or the time needed to ripen them, ten lug boxes of fruit from each test were subjected to the usual ripening treatment employed by the cannery. The fruit was simply held in the lug boxes at ordinary temperatures, which ranged from 70° F. to over 90° F. At the end of nine days some of the fruit was ripe enough to can, and the whole lot was sorted and the ripe fruit and green fruit weighed. In this manner an indication of the relative rate of ripening in the various lots was obtained.

The last column in Table 2 shows the percentage of ripe pears nine days after treating with oil emulsion. In spite of considerable variation in the results, it is apparent that ripening was delayed somewhat by the

TABLE 2. EFFECT OF TREATING PEARS WITH OIL EMULSIONS IN FRUIT-WASHING MACHINE, YAKIMA, WASH., 1929

No.	Treatment	Viscosity of oil (Saybolt at 100°F.)	Unsulfonated residue, 37N sulfuric acid	Number of codling moth eggs examined	Per cent eggs dead	Per cent fruit ripe 9 days after treatment
			Per cent			
1	Light summer oil (miscible), 0.8 per cent oil	53	90	175	100.0	46.3
2	Do., 0.8 per cent oil; casein spreader, 1 pound to 200 gallons	53	90	—	—	66.2
3	Medium summer oil (emulsion), 0.8 per cent oil	82	92	273	100.0	28.7
4	Do., 1.2 per cent oil	82	92	7	100.0	33.8
5	Do., 1.6 per cent oil	82	92	—	—	51.1
6	Do., 1.6 per cent oil; casein spreader, 1 pound to 200 gallons	82	92	—	—	40.2
7	Heavy summer oil (emulsion), 0.8 per cent oil	130	95	33	100.0	20.2
8	Do., 1.2 per cent oil	130	95	84	100.0	28.9
9	Do., 1.2 per cent oil; casein spreader, 1 pound to 200 gallons	130	95	—	—	63.3
10	Dormant oil emulsion, 0.8 per cent oil	106	70	75	96.0	65.6
11	Check	—	—	134	11.2	61.9

summer oils, and that less delay was caused by the light oil than by the heavier oils. The dormant emulsion had no effect on ripening. The slight delay apparently caused by the oil is of no practical significance.

Pressure tests of the pears were also made, but the individual fruits varied so much that these tests were of no value.

CONCLUSIONS

1. Cold-storage temperatures of 26° to 33° F. for five days kill about 50 per cent of codling moth eggs deposited on fruit. Probably similar temperatures for at least ten days or two weeks would be necessary to kill all of the eggs.

2. The eggs are not killed by the usual washing treatment for removal of spray residue.

3. Codling moth eggs on cannery fruit may be killed by spraying the fruit with oil emulsion in a machine used for spray-residue removal. A light summer or dormant type oil emulsion should be used containing about 1 per cent of actual oil. The fruit should not be rinsed and it is not necessary to dry it in warm weather. No bad effects result from this treatment. If it is desired also to remove the spray residue, as in the case of fruit that is to be packed, this should be done first, followed by the oil-emulsion treatment.

CODLING MOTH ACTIVITY IN THE WENATCHEE VALLEY AS SHOWN BY TRAP RECORDS

By ANTHONY SPULER

ABSTRACT

Bait traps have served as efficient indicators of codling moth activity in the apple orchards of the Northwest. Trap records taken from various sections of the Wenatchee valley show that there is a marked similarity in moth activity in all parts regardless of temperature conditions. Such factors as soil type, cultural practices, cover crops and exposures are of relative unimportance in determining the time when the moths become active and deposit eggs in the orchards. Moth activity is approximately the same in widely separated locations and under totally different conditions.

The use of bait traps as indicators of codling moth activity in orchards was reported in 1926.[1] Since that time the traps have been utilized by a large number of growers as a means of determining spray dates. In almost every case where the traps have been so used growers have reported them of value in giving them information on the time and relative abundance of moth flight and oviposition. It has been generally recognized that the codling moth deposits but few eggs unless temperatures at dusk are near 60 degrees Fahrenheit. Trap records show that relative few moths are caught in the traps unless temperatures at dusk are favorable for egg-laying. The moth catch in the bait traps is, therefore, an indication to the grower that eggs are being laid in the orchard. Since bait traps catch large numbers of moths, often as high as 50 moths per trap per night, they serve remarkably well for this purpose.

Prior to the use of bait traps for determining spray dates it was assumed that each particular orchard presented conditions which affected emergence and egg-laying of the codling moth. It was thought that different soil types, absence or presence of a cover crop, types of tree growth, exposure to the direct rays of the sun and locality were important factors which so affected codling moth activity that it was necessary to spray at different times for each condition or locality.

A study of moth trap records in various orchards in the same and different localities have been made during the past four years and it appears that these factors are relatively unimportant in planning a spray program. In fact the trap records indicate that codling moth oviposition is so little affected by orchard conditions that information regarding the time when young worms are likely to begin entering the fruit can be secured by some centrally located individual in a district. Of course it will be necessary for each grower to keep trap records to

[1]Proc. Wash. State Hort. Soc. Rept. 1926.

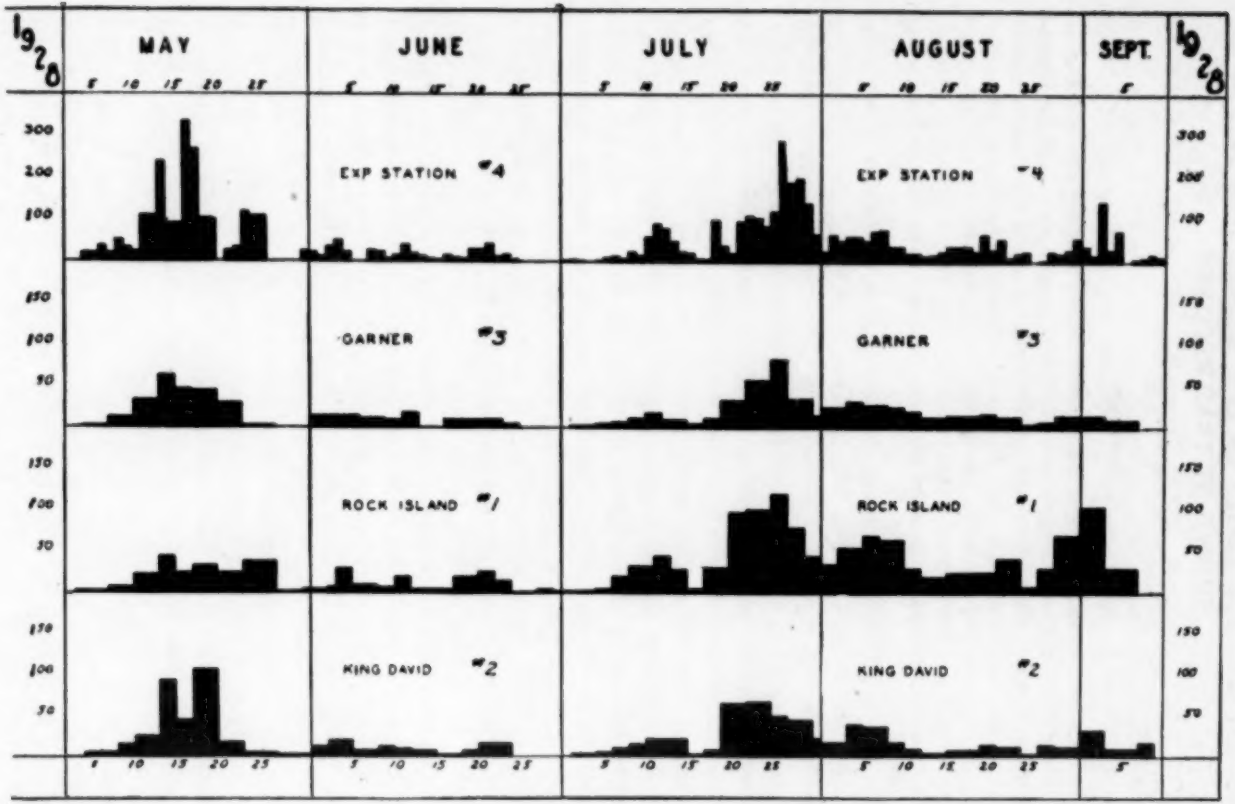

FIG. 68.—Trap record in four orchards for 1928.

determine the relative abundance of moths in his particular orchard for this will vary according to the degree of infestation the year before and the thoroughness with which the sprays are applied.

In 1927 and again in 1928 a series of bait trap tests were conducted in four orchards to determine what effect such factors as soil type, cover crop, exposure and locality had on the activity of the codling moths. Each of the four orchards presented a combination of conditions different from the other three. Orchard number one was located at Rock Island in one of the warmest localities in the Wenatchee Valley. This particular orchard had a western exposure, the trees were small, affording but little shade to the soil, the soil was very sandy and had no cover crop. All of these conditions favored high temperatures for the hibernating larvae in the soil at the base of the tree or on the tree itself.

Orchard number two was located north of Wenatchee and about twelve miles from the first orchard. This orchard contained fairly large trees but these were not crowded, the soil was slightly sandy and was clean cultivated. The orchard had a southern exposure. Temperatures in this orchard were high but not as high as in orchard number one. Orchard number three was located south of Wenatchee, contained large crowded trees, a heavy soil and heavy cover crop. This orchard had a northern exposure and the lowest temperatures of the four tested. The last orchard was the experimental orchard located near Wenatchee. This orchard had a heavy soil, large trees, a poor cover crop and an eastern exposure.

Ten traps were placed in each orchard and regular inspections made. The results of the moth catch in these traps are shown in figure 68.

It will be noted that moths were first caught in numbers in all of the four orchards on approximately the same day. From that time on the catch is not continuous but during the spring month is largely influenced by evening temperatures. However, the fluctuations in numbers caught are the same in all of the orchards and even continue thru the second brood activity when evening temperatures are not a factor, since temperatures at dusk during July and August were rarely below 60 degrees.

Moth trap records do not give information on the actual emergence of the codling moth since the moths may emerge and because of unfavorable weather for flight or oviposition remain inactive for some time. It is quite likely that moths in the warmer locations emerged before the others but because of unfavorable evening temperatures were not caught in the traps until some time later.

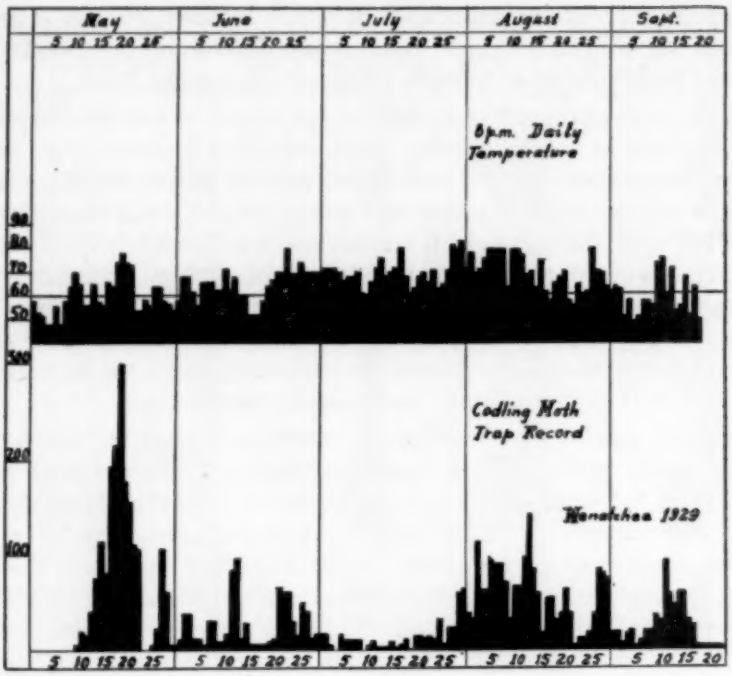

FIG. 69.—Trap records in experimental orchard Wenatchee 1929.

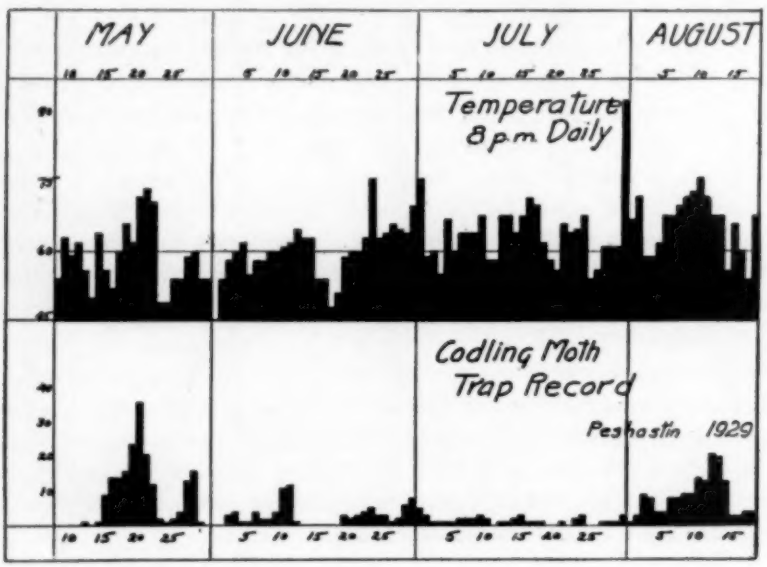

FIG. 70.—Trap records in representative orchard at Peshastin (1929).

A study of the temperature records in the four orchards show considerable differences in maximum and mean daily temperatures. However, when temperatures at eight o'clock in the evening are compared it will be noted that during May and June these fluctuate above and below the 60 degree mark at approximately the same time. In other words periods of warm temperature extend over the entire valley at the same time and usually bring temperatures above 60 degrees at dusk even in the colder parts of the valley. As stated before, moth emergence is earlier in the warmer locations and this is reflected in the traps when temperatures are favorable for flight, by larger catches.

Temperature has been regarded as one of the chief factors in codling moth development. While temperature is certainly an important factor in insect development it certainly is not the only important one affecting the development of the codling moth. In referring again to Fig. 68, it will be noted that the moth catch in the warmest orchard extended over the longest period of time in the spring. It has generally been believed that under favorable temperature conditions the moth emergence in the spring would be rapid and over a relatively short period of time. In comparing the results of the trap tests in the four orchards during July, August and September, it will be noted that the same fluctuations exist in all four orchards thruout the season. This seems to hold true regardless of evening temperatures.

Thru the courtesy of Mr. Geo. Harter, Supervisor of Horticulture, State Department of Agriculture and Mr. Robert Campbell, District Horticulture Inspector at Wenatchee, it was possible for the writer to obtain moth trap records in all the various parts of the Wenatchee Valley. It would not be possible to present all this material in a paper of this kind because of limited time. However, a general idea of the moth activity in different parts of the valley can be obtained from the records of two orchards presenting entirely different conditions. These are shown in Figures 69 and 70.

Wenatchee is located in the warmer portion of the Wenatchee Valley. Trees come into bloom in this district about a week earlier than in the Peshastin district which is in the upper part of the valley. A comparison of the records in Figure 69 with that of Figure 70 shows a similarity which is quite marked.

The chief differences in the record of the two localities is in the number of moths caught in the traps. At Wenatchee the calyx spray is applied a week earlier than it is at Peshastin yet the time of general moth flight in the two districts is approximately the same. The calyx spray in the Wenatchee district is often applied before many moths are caught in

the traps and a cover spray is necessary to take care of the general activity later on. In the Peshastin section the moths usually fly and lay eggs at the time the calyx spray is applied and this spray takes the place of a first cover. Trap records in all of the upper portion of the Wenatchee Valley, the Chelan district and the Okanogan and Oroville sections show a low moth catch. In none of these sections is the codling moth a serious pest. In the lower Wenatchee Valley the moth catch is relatively large and usually comes at a time when fruit has attained considerable size. This is a factor in control since the codling moth begins to lay her eggs on the fruit as soon as it shows considerable size and the newly hatched worm has less opportunity of becoming poisoned than if forced to travel from the leaves or twigs to the fruit. Comparisons of trap records in districts as widely separated as Wenatchee, Wash., Yakima, Wash., and Parma, Idaho show that moth activity thruout the summer is approximately the same in all of them.

As previously stated the codling moth may emerge some time before favorable weather induces it to fly and enter the traps. However, continued entry into the traps must to some extent at least be dependent on moth emergence, since the average life of the moths in the orchard is not very long.

In 1929 the trunk of a living tree was caged as shown on plate 30 and stocked with approximately 1400 larvae, all of which were taken from tree bands within a period of two weeks. This was done to determine how long it would take for all the worms in a cage to emerge. The worms were allowed to enter the soil or hibernate under the bark of the trunk. Moths began to emerge in this cage on the 30th day of April and are still emerging at the rate of 15 to 20 a day at the time this paper was prepared (June 15). The temperatures during the past winter have been very low and for a few days reaching 19 degrees below zero Fahrenheit. As a result there was a rather high mortality in the hibernating worms. At the writing of this paper over 300 moths had emerged. As far as could be determined all of the larvae in the cage were subjected to approximately the same temperature conditions yet emergence from the trunk and soil has continued almost two months and may continue for some time yet.

The trap records are proving to be of greater value to the grower than the older method of caging larvae, since they are based on actual moth flight and oviposition under natural conditions in the orchard. The grower is not directly concerned with the time of emergence of the codling moth but is vitally interested in the time the moth is laying eggs in the orchard. As shown by the trap records oviposition may be delayed for a

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Codling moth cage about base of apple tree.

considerable period and many moths may emerge and lay relative few eggs because of unfavorable weather.

The bait traps show that moth activity is not uniform thruout the season but appears to fluctuate up and down and most of the eggs in both first and second broods are laid in a relatively short period of time. This information is of great value when ovicidal sprays such as oils or nicotine compounds are used.

CONTROL OF THE EARWIG BY THE EUROPEAN GROUND BEETLE, *PTEROSTICHUS VULGARIS*

also

CONTROL OF THE EUROPEAN BROWN SCALE BY CHALCID PARASITES

By TREVOR KINCAID, *University of Washington, Seattle, Wash.*

(Papers not received)

EXPERIMENTS WITH BAITS FOR STRAWBERRY ROOT-WEEVILS IN OREGON

By J. WILCOX and DON C. MOTE, *Oregon State Agricultural College*

(Paper not received)

THE USE OF PINE TAR OILS AS INSECTICIDES AND FUNGICIDES

By E. R. DE ONG

(Paper published elsewhere)

RESULTS OF AIRPLANE DUSTING IN THE CONTROL OF COTTON BOLL WORM (*HELIOTHIS OBSOLETA* FAB.)

By FRANKLIN SHERMAN, *Department of Entomology, Cornell University*

ABSTRACT

Large scale airplane dusting operations in the Brazos River Bottoms near College Station, Texas, in 1927 indicated that boll weevil might be successfully controlled by the use of from five to six pounds of calcium arsenate per acre. Boll worms however, were not controlled and increased on the dusted area throughout the season. General observations indicated that more boll worm damage appeared on the heavily dusted cotton than on the untreated areas.

During the summer of 1927 a large acreage of cotton was dusted by airplanes in the Brazos River bottoms of Texas. The purpose of this dusting was to control three important pests of cotton, the boll weevil, the cotton leaf worm, and the cotton bollworm.

Throughout the dusting period the writer was engaged in close observations of the results obtained on the J. O. Chance plantation, located in Burleson County, Texas.

The results obtained in controlling the boll weevil, of which there was a very heavy infestation, have been published in The Texas Experiment Station Bulletin 394. Table 1 summarizes the reduction in boll weevil infestation secured by dusting and Figure 71 illustrates this diagramatically.

POISON APPLICATIONS. From five to six pounds of calcium arsenate was applied per acre. Applications were made mostly in early morning when plants were wet with dew. Airplanes used were furnished by Huff-Deland Dusters, Corp., and the pilots were men experienced in cotton dusting. Three applications were made on all of the dusted areas and on heavily infested portions, four applications were made.

GENERAL CONDITIONS. The Chance plantation is located on the west bank of the Brazos River, extends back from the river about four and one-half miles, and consists almost entirely of river bottom land. Slightly less than 3,000 acres were planted in cotton. Scattered here and there throughout the large cotton fields were numerous small fields of corn. Since the owner greatly feared bollworm damage, numerous counts were made in early June to determine the abundance of *H. obsoleta* in corn. At this time practically every ear was infested with one or more larvae. When dusting operations began on July 14, close observations were made on the activities of the bollworm on the dusted areas of cotton.

METHODS OF OBSERVATION. Before the first application of dust a survey of the infested area showed that 30.2 per cent of the squares were being damaged by boll weevil. At this time there was little evidence of bollworm damage. Certain plants were selected at various areas throughout the acreage in cotton. After each application of poison 100

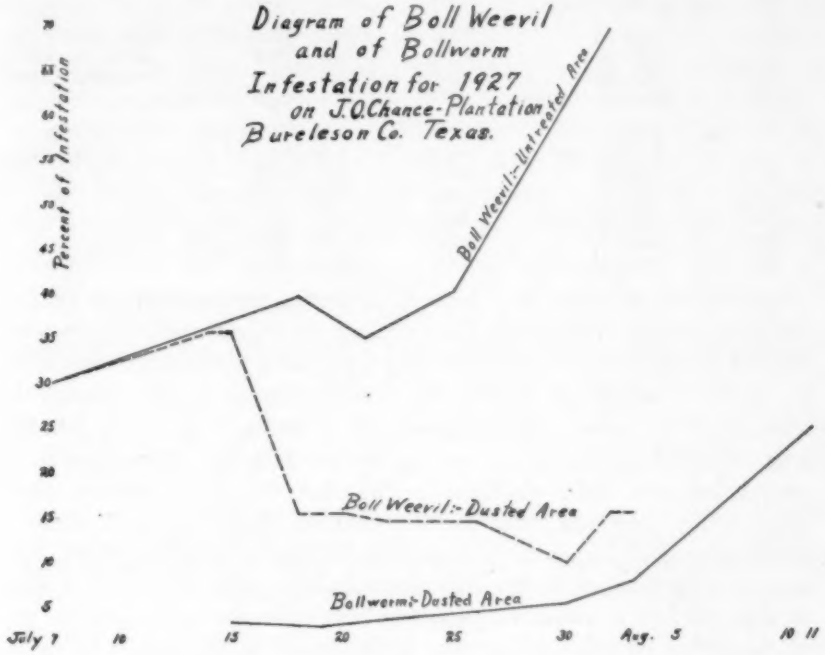


FIG. 71

squares were examined on the selected plants at the different points. Records were taken at the time of each examination for boll weevil and bollworm damage. The records on August 11 were taken on bolls only, since very few squares were present at this time. The untreated area was a ten acre field left as a check to be used in comparison with the dusted area.

RESULTS OF THE DUSTING. The following table presents a summary of the infestation data secured during the course of the summer. Figure 1 represents diagramatically the boll weevil infestation on treated and untreated areas, and the bollworm infestation on the treated area. Since but little bollworm infestation developed on the ten acre check infestation data is not included for this area.

TABLE 1. SUMMARY OF BOLL WEEVIL AND BOLL WORM INFESTATION DATA

Places Examined	Dates Examined	No. squares Examined	Percentage of Infestation Mean	Max.	Min.	
21	July 14–15	2100	36.9	62.0	21.0	Boll Weevil In-
30	July 18–20	3000	15.3	38.0	2.5	festation Data:
30	July 22	3000	14.6	24.0	1.5	Dusted Area
30	July 26	3000	13.4	18.5	1.5	
18	July 30	1800	10.0	39.0	2.0	
30	Aug. 2–3	3000	15.3	42.0	4.0	
12	July 18	1200	39.8	62.0	28.0	Boll Weevil In-
12	July 21	1200	35.2	58.0	17.0	festation Data:
12	July 25	1200	40.5	64.0	14.0	Undusted Area
12	Aug. 2	1200	69.1	86.0	47.0	
9	July 15	900	2.1	7.0	0.0	Boll Worm In-
18	July 18–19	1800	1.4	4.0	0.0	festation Data:
18	July 22	1800	2.7	7.0	0.0	Dusted Area
18	July 26	1800	3.5	9.0	0.0	
18	July 30	1800	5.2	12.0	1.0	
18	Aug. 3	1800	10.5	23.0	0.0	
18	Aug. 11	1800	24.5	43.0	1.0	

DISCUSSION OF RESULTS. A study of the figures presented in Table 1 and of the curves presented in Figure 71, clearly indicates that no practical control was secured over the bollworm by dusting with calcium arsenate. At all places where infestation was observed, when dusting began, the infestation continued to increase in spite of dusting. Not only was this true where calcium arsenate was applied by airplane, at from five to six pounds per acre, but it was equally true on certain demonstration plots, where every care was taken to secure thorough dusting and where as much as twelve pounds of calcium arsenate per acre were applied. One such plot was dusted at five day intervals from June 29th to July 30th. In this plot boll weevil infestation was high when dusting began but was so controlled by the dusting that bolls formed to the very tops of the plants. However, bollworm damage continued and by August 10th many bolls saved from the boll weevil were ruined by the bollworm. On this plot, dust applications began before eggs, larvae, or adults of bollworm were observed in cotton although hundreds of plants were examined each day during June.

UNUSUAL TYPE OF DAMAGE. In addition to the usual types of damage, the writer observed nearly grown larvae of the bollworm in the act of cutting off from four to six inches of the terminal portion of the cotton plants by feeding in the stem. This form of damage was common in a heavily infested field of young cotton on July 13th. So far as the writer knows this type of damage had not been reported in the field, although it is reported as having occurred where many larvae were confined on plants covered by cages. (U. S. D. A., Bulletin 50, Bureau of Entomology.)

GENERAL OBSERVATIONS. Since bollworm damage was so severe on certain portions of the dusted plantation, the writer made numerous observations to determine whether this damage was as severe on undusted plantations. While these observations were of a superficial nature it is believed that they were numerous enough to be of value. It appeared without exception that bollworm damage was heaviest on the areas that had been dusted or in nearby fields. No attempt is made to explain this infestation but nevertheless in places the evidence seemed striking. In addition to these observations concerning this point the writer wishes to state that in a conversation with Mr. R. K. Fletcher, Entomologist of The Texas Experiment Station, he was informed that the same condition seemed to occur during the summer of 1928 although at this time the dusting was much less extensive than during 1927.

SOME FACTORS AFFECTING THE INFESTATION OF ORIENTAL FRUIT MOTH

By S. W. FROST, *The Pennsylvania State College*[1]

ABSTRACT

The infestation of *Laspeyresia molesta*, where several varieties of peach are grown together, is discussed in relation to certain factors as: twig growth, fruit growth, abundance of fruit, temperature, precipitation, etc. Twig growth, abundance of fruit and broods determine more than any other factor the nature of the infestation.

It has long been suspected that certain factors contribute to the abundance and distribution of the oriental fruit moth but no definite figures are available, up to the present time, to verify this. During the summer of 1929 an attempt was made to gather data bearing on this point and some preliminary figures are given. A number of factors that seemed to have some bearing on infestation were taken into account. These can be divided into two classes: (A) Factors uniform for all varieties; (B) Factors varying in different varieties. To class A belong: temperature, precipitation, other weather conditions, broods, parasitism etc. To class B belong: initial infestation, location (nearness to packing shed or edge of orchard), twig growth, fruit growth, ripening and picking of peaches, abundance of fruit and the possible susceptibility of different varieties.

[1]Publication authorized by the Director of the Agricultural Experiment Station as Technical Paper No. 498.

TABLE 1. COMPARISON OF TWIG GROWTH AND TWIG INFESTATION, ADAMS CO., PA., 1929

Variety	June 1 Twig growth	June 1 Twig infest	June 10 Twig growth	June 10 Twig infest	June 17 Twig growth	June 17 Twig infest	July 2 Twig growth	July 2 Twig infest	July 18 Twig growth	July 18 Twig infest	July 30 Twig infest	Aug. 15 Twig infest	Total Twig infest
Hiley[1]	4.9	7	5.3	47	6.1	28	8.8	34	10.1	129	23	13	281
Hiley[2]	5.1	1	7.7	12	10.9	11	14.4	49	20.6	133	49	47	302
Belle Georgia[2]	6.7	4	6.4	17	7.8	7	17.8	45	15.7	148	58	18	297
Hale[1]†	4.0	8	4.3	43	4.8	24	10.1	37	12.0	224	80	13	429
Hale[1]*	4.9	6	5.2	26	7.0	19	8.5	27	10.4	134	31	12	255
Hale[2]	6.9	3	9.5	21	13.8	20	21.5	34	25.8	147	79	46	350
Early Elberta[1]	4.0	11	4.0	50	6.1	26	10.3	37	13.4	158	57	19	358
Early Elberta[2]	5.3	2	4.9	10	6.1	3	12.0	24	14.4	72	34	23	168
Late Elberta[2]	5.4	26	5.9	115	5.2	11	6.4	64	7.8	125	14	7	362
Krummel[1]	1.8	1	1.9	44	2.9	12	2.9	5	3.5	14	9	7	92
Total twig infestation		69		385		161		356		1284	434	205	2894

Legend—Twig growth measured in Cm. Infestation = number injured terminals. [1] old trees. [2]young trees. †unpailed trees. *pailed trees.

An orchard of 10,000 bearing trees was selected where different varieties, including both young and old trees, were growing together. Infestation was determined by clipping injured twigs, gathering and examining fruits and by means of bait-traps.

TWIG INFESTATION. The twig infestation was determined by clipping all infested terminals about once a week from five trees located near the middle of each variety, using the same trees each week and employing ladders to reach the tops of the trees. During 1929 the infestation was unusually low. The first infested twig was seen on May 28th but they were not abundant enough to be noticeable until June 1. Twig infestation continued until August 15th, after which injured terminals became scarce. The infestation was generally greatest upon the young trees. The highest infestation (429 terminals) occurred in a block of unpailed Hale adjacent to a similar block of Hale which was pailed and showed an infestation about half as great (225 injured terminals). Twig infestation was lowest (92) in the Krummel block where twig growth was least. There were no dehorned trees during 1929. Such trees always show high twig infestation.

It is evident that twig infestation continued rather strongly after the terminals had hardened (about July 15th), although the maximum twig infestation occurred about June 10th, shortly after the initial infestation.

Figures taken during 1928 on dehorned Late Elberta in the same orchard show somewhat higher infestation. Infested twigs were collected from twenty-three dehorned trees as follows.

TABLE 2. INFESTED TERMINALS CLIPPED FROM 23 DEHORNED ELBERTA, 1928.

Date	No. Infested terminals	No. worms recovered	
June 6	150	61	
" 8	200	60	
" 11	125	36	
" 13	70	22	Brood I
" 20	60	6	
" 28	20	3	
July 3	12	0	
" 12	582	174	
" 16	233	78	
" 17	401	75	Brood II
" 20	298	78	
" 23	198	35	
" 31	172	12	
Aug. 2	135	8	
" 9	147	55	
" 15	270	86	Brood III
" 21	388	88	
" 28	190	22	
Totals	3651	899	

TWIG GROWTH. Measurements were made in the orchard, in centimeters, about once a week of fifty terminals taken at random from trees near the centers of the blocks shown in Fig. 72. No water sprouts, suckers or injured twigs were measured. Growth was well under way by June 1 and the twigs hardened about July 15, this varying somewhat in the different varieties. Belle of Georgia reached maximum growth about July 2. Twig growth in the Krummels was noticeably small throughout the sum...

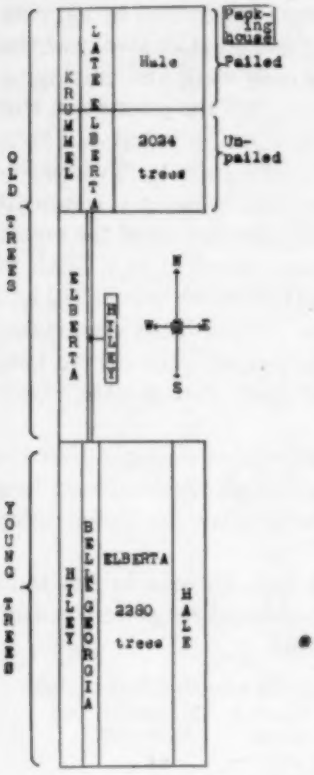


FIG. 72.—Diagram of Experimental Orchard.

FRUIT INFESTATION. One hundred fruits were taken once every other week from trees near the center of each variety. These collections were made from June 10th until July 30th, when the orchardist finished his thinning and it was not practical to take further fruits. To avoid personal judgment in selecting the fruits, the following rules were adhered to: when three fruits hung close together on a branch, the middle fruit was always selected; when two or more fruits hung adjacent, the right-hand fruit or fruits were selected.

All of the fruits (1000 at each collection) were taken to the laboratory and placed in battery jars with strips of corrugated paper and covers of cheesecloth. Daily records were made of the larvae, pupae and adults found in the jars. This method was continued for each collection of fruit for three or four weeks so as to be certain that all of the oriental fruit moths had emerged. It was found more accurate than cutting fruits, especially when the fruits were small and green and when the larvae were minute.

Records were also made of the curculio infestation in a similar manner. The results are summarized in the following table.

It is evident from Table 3 that curculio injury upon peaches hanging upon the trees became less and less until at picking time the percentage approximated zero. The loss from curculio, therefore, is not entirely evident in the picked fruit. The greatest curculio infestation occurred

TABLE 3. PERCENTAGES OF CURCULIO AND ORIENTAL FRUIT MOTH INJURY, ADAMS COUNTY, 1929

Variety	Date	O. F. M.	Curc.	No. of fruits
All*	June 10	.8	14.0	1,000
All*	" 27	1.0	10.0	1,000
All*	July 10	1.5	5.0	1,000
All*	" 30	3.0	1.5	1,000
Hiley	Aug. 6	8.0		400
Krummel	Sept. 26	25.5		1,000

*Includes: Belle of Georgia, Hiley, Hale, Elberta and Krummel.

on a few trees adjacent to a brush pile where conditions were favorable for their development. On August 6th, a few Hiley trees under such conditions showed 25 per cent curculio injury while the average for the whole orchard was less than 1 per cent.

FRUIT GROWTH. The fruits gathered for records of infestation were weighed and measured, length and diameter in centimeters, as soon as they were brought to the laboratory. Only the weights are shown in Table 4. A complete record of fruit growth is given in Table 5.

BAIT TRAPS. One hundred bait traps were arranged throughout the orchard in the different varieties to give an idea of the distribution and abundance of moths during the summer. Ten traps were placed near the center of each variety. The baits were all mixed at the same time and the traps were set on the same day. They were replenished four times during the season in order to keep them in prime condition, and they were examined once a week and the catches were taken to the laboratory for study and counts. The figures show that the moths were flying during early summer among the old trees on the north side of the orchard and during the late summer among the young trees towards the south end of the orchard. This is probably due to the fact that the larvae winter over largely on the older trees, especially the late variety Krummel, at the north end of the orchard. The packing house at the northeast side of the orchard also helps to explain the difference in moth population.

In addition to the bait traps, 1,000 pails were hung in the varieties Hale, Late Elberta and Krummel, placing a pail on every other tree in every row as indicated in the diagram of the orchard (Fig. 72). These baits were set on April 15th and were replenished on June 1st, receiving no further attention during the remainder of the season. Some apparent effects of these baits may be seen when the pailed and unpailed blocks are compared with respect to terminal injury (Table 1) and captures from bait traps (Table 6).

TABLE 4. COMPARISON OF FRUIT GROWTH AND FRUIT INFESTATION, ADAMS CO., PA., 1929.

Variety	JUNE 10 Fruit weight	JUNE 10 Fruit infest	JUNE 27 Fruit weight	JUNE 27 Fruit infest	JULY 10 Fruit weight	JULY 10 Fruit infest	JULY 30 Fruit weight	JULY 30 Fruit infest	AUGUST 1 7 14 21 28 / SEPTEMBER 1 7 14 21 28 — Periods of ripening.
Hiley[1]	14.4	1%	32.0	1%	41.0	6%	68.5	2%	
Hiley[2]	17.0	0	34.0	1%	34.0	3%	54.0	9%	
Belle georgia[2]	19.0	0	30.0	0	39.0	2%	47.5	0	
Hale[1*]	25.0	0	42.0	0	52.0	3%	77.0	7%	
Hale[1+]	22.0	0	43.5	1%	49.0	1%	78.5	3%	
Hale[2]	26.5	1%	40.5	0	53.5	2%	85.5	3%	
Early elberta[1]	18.0	1%	35.0	0	43.5	3%	62.5	4%	
Early elberta[2]	17.5	1%	29.0	0	40.0	0	54.0	2%	
Late elberta[2]	15.5	3%	41.5	1%	35.5	2%	50.0	1%	
Krummel[2]	14.0	1%	20.5	4%	46.5	4%	33.0	5%	

Legend.

Weight in grams.
1= old trees
2= young trees
+= unpailed trees
*= pailed trees

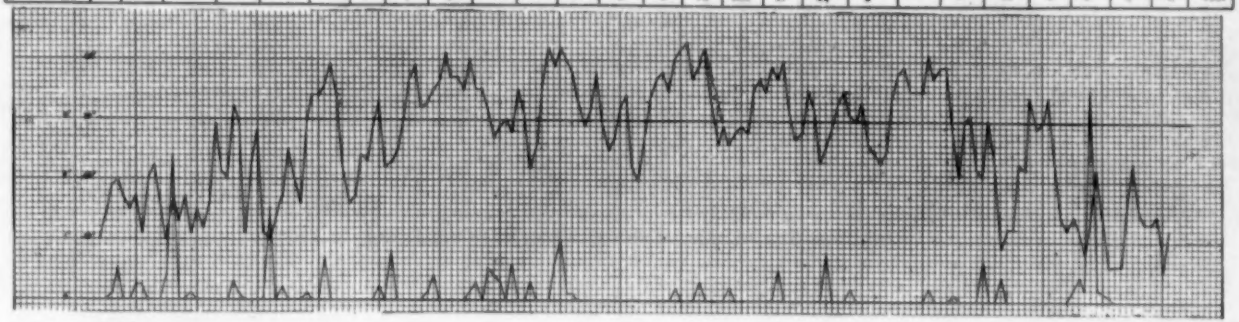
TABLE 5. FRUIT GROWTH, RICE ORCHARD, ADAMS CO., PA., 1929

Variety	June 1			June 10			June 18			June 27			July 10			July 30		
	Lgth.	Diam.	Wt.	Lgth.	Diam.	Wt.	Lgth.	Diam.	Wt.	Lght.	Diam.	Wt.	Lght.	Diam.	Wt.	Lgth.	Diam.	Wt.
Hiley[1]	3.5	2.7	10.5	3.9	2.9	14.5	4.1	3.4	23.0	4.5	3.8	32.0	4.8	4.2	41.0	5.8	5.0	68.5
Hiley[2]	3.6	2.8	11.5	4.0	3.2	17.0	4.0	3.4	21.0	4.9	3.9	34.0	4.5	4.0	34.0	5.1	5.0	54.0
Belle Georgia[2]	3.7	2.7	12.0	4.0	3.3	19.0	4.2	3.6	26.0	4.6	3.9	30.0	4.7	4.1	39.0	5.1	4.4	47.5
Hale[1]†	3.7	3.7	17.0	4.2	3.7	25.5	4.8	4.2	39.5	5.1	4.4	42.5	5.0	4.5	52.0	5.6	5.3	77.0
Hale[1]*	3.8	3.1	14.5	4.0	3.5	22.0	4.7	4.1	40.0	4.8	4.5	43.5	4.9	4.7	49.0	5.4	5.4	78.5
Hale[2]	4.0	2.9	14.0	4.6	4.2	26.5	4.8	4.2	39.0	5.0	4.2	40.5	5.0	4.7	53.5	5.8	5.3	85.5
Early Elberta[1]	3.4	2.6	9.5	4.1	3.3	18.0	4.4	3.8	29.0	4.7	4.1	35.0	5.0	4.3	43.5	5.4	4.8	62.5
Early Elberta[2]	3.5	2.6	10.5	3.9	3.2	17.5	4.4	3.6	25.0	4.6	3.6	29.0	4.9	4.2	40.0	5.1	4.4	54.0
Late Elberta[1]	3.7	2.8	13.0	3.5	3.0	15.5	4.7	3.8	31.0	4.9	4.3	41.5	4.4	4.0	34.5	5.3	4.3	50.0
Krummel[1]	2.8	2.4	7.0	4.0	2.9	14.0	3.8	3.4	21.0	3.9	3.4	20.5	5.0	4.3	46.5	4.4	3.7	33.0

Length and diameter of fruit measured in Cm, weight of fruit in Grams. [1]=old trees. [2]=young trees. †=unpailed trees.
*=pailed trees.

TABLE 6, BAIT COLLECTIONS, 1929

Variety	APRIL 23	29	MAY 7	14	22	29	JUNE 4	11	18	25	JULY 2	9	16	23	30	AUGUST 6	13	20	27	SEPTEMBER 3	10	17	24	OCT. 1	8	15	Totals
Riley[1]	0	15	106	17	14	9	6	3	0	0	21	19	13	7	65	101	80	16	3	3	16	21	0	1	0	0	315
Riley[2]	1	13	39	3	4	4	3	0	1	15	14	5	1	2	216	110	26	41	6	64	180	5	5	6	0	0	726
Belle Georgia[1]	0	19	19	2	11	9	1	0	0	4	11	11	3	0	206	206	111	13	0	2	67	87	0	0	0	0	703
Hale[1]	0	170	423	60	12	2	13	1	2	0	14	6	2	2	65	181	56	58	16	58	61	234	24	24	2	2	1420
Hale[2]	0	93	258	33	13	7	10	2	14	14	100	45	6	2	18	83	57	6	0	2	34	64	1	0	1	0	805
Hale[3]	0	4	34	0	9	4	2	1	2	10	30	8	1	1	102	119	44	8	0	4	33	69	16	0	0	0	358
E. Elberta[1]	0	45	113	19	17	22	13	1	0	19	11	10	6	0	97	69	46	25	21	21	68	56	2	2	0	1	516
E. Elberta[2]	0.	21	87	4	7	1	4	1	1	14	8	0	1	1	104	95	46	21	0	2	48	18	0	1	1	0	419
L. Elberta[1]	1	89	510	60	26	8	11	10	2	37	46	29	0	2	61	149	49	14	6	4	103	279	22	6	0	1	1607
Krumel[1]	0	59	88	34	11	1	4	1	1	10	27	26	9	0	71	288	47	21	0	0	86	89	2	1	0	1	795.



LEGEND

Mean daily temperatures in Farenheit
Daily precipitation in 10ths of inches.
1 = Old trees
2 = Young trees
+ = Unpulled trees
0 = Pulled trees

OTHER METHODS OF DETERMINING INFESTATION. Other methods of determining infestation were tried, namely, dusting trees with a 4 per cent nicotine dust, to bring down the moths; banding trees during the summer and winter, to determine larval and pupal population; weekly counts of eggs per leaf on a given number of leaves, to determine the activities of the moths; and similar counts of cocoons upon the peaches during the summer broods. These methods were tried only on a small scale.

CONCLUSIONS. The data scarcely permits us to draw definite conclusions. However, the influence of certain factors is evident.

There is no doubt that succulent, thrifty twigs are attractive to the larvae during the early part of the season. As the twigs harden and the fruit ripens there is a migration to the fruit, and twig infestation naturally becomes less prominent. On certain occasions larvae were found to enter small green fruit during the first brood, in preference to twigs, because the twigs were not making normal growth. On the other hand, very rapid twig growth may force the larvae from the twigs or even kill them.

The increase in number of moths due to new broods during the summer is evident when studying twig infestation, fruit infestation or making collections from bait traps. The duration of each brood can be determined almost as readily by these studies as by rearing methods.

During preceding years, considerable fluctuation has been noted in the percentages of oriental fruit moth injury. In 1925, there was 145 per cent injury on quince; in 1926, 18 to 25 per cent injury on Krummel; in 1927, 80 to 83 per cent injury on Krummel; in 1928, 13 to 18 per cent injury on Krummel; and in 1929, 25½ per cent injury on Krummel. It would be difficult to say what factors cause these fluctuations. It is pretty well known in Adams County, Pa., that the parasitism has been almost a negligible factor. Seasonal conditions no doubt account for most of these yearly differences, which influence not only the initial infestation and broods but also the set of fruit and the growth of twigs and fruit and these in turn have a bearing upon infestation.

BIOLOGICAL NOTES ON APHIDS AFFECTING APPLES WITH SPECIAL REFERENCE TO VITALITY OF EGGS (APHIDIDAE, HOMOPTERA)

By D. L. Moody and H. B. Mills

Abstract

The studies in Iowa show that aphid eggs are quite sensitive to humidity changes in the fall.

Although there has been much work done on aphids affecting apples in other parts of the country, to the knowledge of the writers there has been no work done in Iowa. Therefore some biological notes from this part of the country should be of value. The following notes were taken during the falls of 1928 and 1929.

On October 29, 1925, a cold wave struck the middle-west, bringing zero and sub-zero weather which greatly diminished the numbers of all insects and it has been only the last two seasons that collectors could function with any degree of success. No aphids could be found in the college orchards at Ames, Iowa, during 1926. Extensive searches in the spring of 1927 revealed only one shrivelled egg and no plant lice were seen at all. In the spring of 1928 only a few were found.

Aphis pomi and *Anuraphis roseus* have been abundant in the falls of 1928 and 1929, especially the latter.

Aphis pomi De Geer. The first observations in 1928 were made in the college orchard on October 5. Both males and females of the oviparous generation were found clustered on the tips of the new growth of young trees. The feeding on the under side of the leaves had considerably distorted them and there was much discoloration from honey-dew. One tree out of every 25 was infested in one orchard of young trees. The females were greatly in preponderance and were feeding quietly but for an occasional ovipository sally down the petiole to the stem. The males were moving about mating promiscuously with the females.

Several light frosts occurred during the last of October and the month of November. Immediately after the frosts the aphids were very sluggish but as the day warmed up their vitality was regained and they were apparently uninjured. A severe drop to 4 degrees F. on December 1 and —6 degrees F. on the 6th killed all of the aphids. On December 9th no live ones were to be found.

On October 12, 1929, *A. pomi* was abundant in the orchards. November 5 they were very abundant and eggs were very numerous. On the 15th of the same month they were still abundant and active in spite of rather severe frosts. A period of zero weather beginning November 24, killed all of the aphids.

Anuraphis roseus Baker. The first fall migrants in 1928 were seen in the orchards on October 25. Many of the winged forms were noticed on the undersides of the leaves. The green apple aphis, *A. pomi*, confined itself to the succulent new growth of the tips but *Anuraphis roseus* was found scattered rather evenly over the tree. As might be expected, the eggs of *A. pomi* are concentrated in great numbers at the tips of the twigs while the eggs of *A. roseus* are found more generally distributed. The eggs of *A. roseus* were first seen October 26. Out of thirty trees examined only three were found apparently free from this species. Several colonies were found breeding on pear (*Pyrus communis* L.) and hawthorn trees (*Crataegus* sp.). *A. roseus* continued in numbers through several frosts and light snow storms to the zero weather of the first six days of December when they all disappeared.

In 1929 this species was first seen migrating back to apple trees on October 12. The flight increased up to the 27th when it was very abundant. On this date some population studies were made on trees in a three year old orchard at Le Grand, Iowa. Although pear blight had killed the trees back considerably the year before, there was an average of 13,547 rosy apple aphids per tree. The species was abundant at Ames on November 5, and eggs were quite common. On November 15 they were still abundant and active in spite of several frosts. The zero weather of November 24 killed them.

The eggs of these species, when first laid, are a bright grass green with sometimes a light yellowish tinge but their color changes in a few days to a shiny black. Matheson (1919) states that this color change takes place in from nine days to two weeks after oviposition under outdoor conditions. Experiments conducted on this point seemed to indicate a somewhat shorter period for color change in this latitude. Oviparous females were put on uninfested apple twigs and were allowed to remain for 24 hours. At this time they were removed, the eggs counted, and the twigs placed out of doors near the laboratory. The average time required for a complete color change was six days, there being a variation of from two to nine days. Two per cent of the eggs did not change to black but turned a dark brown. Other twigs left in the laboratory showed a color change in the eggs in an average of three days. Peterson (1919) says that some *A. avenae* eggs do not change color but retain their greenish tinge throughout the winter, but these, he thinks, are abnormal.

It has been noted by several workers that the number of eggs hatching in the spring is greatly lower than the number laid in the fall. Gillette and Taylor (1908) state that in Colorado but one per cent of the eggs of *A. pomi* hatched. Peterson (1919) observed that from thirty to fifty

er cent of the eggs of *A. avenae* hatched and in a mixture of the eggs of *A. pomi* and *A. roseus* the hatch was near twenty-five per cent. Matheson (1919) gives the following reasons for this low percentage: (1) Climatological factors, including sudden temperature changes and the effect of cold rains near or at hatching time, (2) Predaceous insects and birds, and (3) Non-fertilization of the eggs.

It seems very possible to the writers that another factor may in part account for the high egg mortality. The eggs are quite sensitive to humidity changes in the fall, especially before the change in color. On December 9, 1928, after all of the adults had been killed, a check was made on 1,241 eggs of *A. pomi* and the following data were recorded. Normal black eggs were in preponderance with 73 per cent. There were 5.6 per cent of green and 21.4 per cent of shrivelled eggs. These eggs were kept in the laboratory at a temperature of from 70 degrees F. to 80 degrees F. and an average relative humidity of 27.5 per cent. At the end of six weeks they were examined and practically all had shrivelled.

Another small experiment was carried on to check the results above. One hundred plump black eggs from one twig were divided into two lots of fifty each; one was placed in outdoor conditions and the other was kept in the laboratory. At the end of eleven days the eggs that were kept in the laboratory with a temperature of 70 degrees F. to 80 degrees F. and with a relative humidity of 27.5 per cent had entirely shrivelled while those outside with a temperature averaging just above freezing and an average relative humidity of 77 per cent had shrivelled only 10 per cent.

On November 22, 1929, 350 eggs of *A. pomi* were brought into the laboratory and divided into four lots which were subjected to humidities of 0, 33, 73 and 100 per cents. The temperature in the laboratory was near 80 degrees F. and was the same for all four of the humidity chambers.

Of the eggs at 100 per cent humidity, 10 per cent shrivelled at the end of four days; at 73 per cent humidity 20.4 per cent shrivelled in the same time; at 33 per cent humidity 24.3 per cent shrivelled; and at 0 per cent humidity 51 per cent shrivelled. These results would indicate that there was a direct bearing of humidity on the shrivelling of eggs in the fall. It is admitted that this experiment is somewhat superficial and will need rechecking with larger numbers of eggs and different temperatures.

It would seem, though, that a period of low humidity after oviposition in the fall would cause considerable dessication and might be responsible in a measure for the low hatching percentage of aphid eggs in the spring.

Summary and Conclusions

After the early freeze (in October, 1925) aphids were very scarce in central Iowa until the fall of 1928 when *Aphis pomi* was found in no large numbers and *Anuraphis roseus* fairly abundantly. In the fall of 1929 both species were quite abundant. In 1928 *Anuraphis roseus* was seen returning to the apple the first week in October. Both species continued oviposition until the freeze of December 1. *Anuraphis roseus* was seen migrating to the apple in small numbers on October 12, 1929 and the oviposition of both species was stopped by zero weather

Checks on aphid eggs at Ames, Iowa would indicate that the small hatching percentage of the eggs in the spring might be due to dry atmospheric conditions after oviposition in the fall.

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DROUGHT-AFFECTED AND INJURED TREES ATTRACTIVE TO BARK BEETLES

By R. A. St. George, *Bureau of Entomology*

Abstract

Hickory and pine trees were reported to be dying from bark beetle attack in several localities and it was found that these trees were affected by a lack of precipitation or were near trees that had been injured by such agencies as wind and lightning and that had thus become attractive to the beetles.

During the past summer additional evidence came to the writer's attention indicating that a special attractiveness of the host tree to bark beetles is created by certain influences directly affecting the tree. These cases appear to be of sufficient interest to be put on record.

Trees Affected by Drought. The city forester of Lansing, Michigan, reported on September 11, 1929, that in Bancroft Park there were between 400 and 500 hickory trees (mostly of the pignut type), of 15 inches diameter breast high and under, that were either dead or in a

dying condition, and that the trees contained broods of the hickory bark beetle (*Scolytus quadrispinosus* Say) in all stages of development.

Surmising that there was a deficiency of rainfall in this region which might have affected the trees and therefore made them attractive to bark beetles, the writer examined the records of the Weather Bureau for that region. It was found that a deficiency had occurred and that it coincided with the period of bark beetle attack.

The first hickory trees were attacked about August 1, and by September, when the foliage on about 70 per cent of them had begun to wilt, the infested trees had increased from a few to nearly 500.

During the period of June, July, and August, when the beetles were most active, there was a deficiency of 1.34 inches, 1.20 inches, and 2.53 inches of rainfall, respectively. This situation bears a close similarity to that which existed in Swannanoa, North Carolina, in 1925, where dying hickories were found to be weakened from the effects of drought and subsequent bark beetle attack. In this instance the lack of moisture checked the growth of the trees. Also, as in Lansing, Michigan, the greatest deficiency came during June, July, and August, when the maximum precipitation normally occurred and when the beetles were most active.

On several occasions pine trees also were found to be in a dying condition and were invariably infested by bark beetles, either Ips or the southern pine beetle (*Dendroctonus frontalis* Zimm.) These attacks are noted below.

Between 450 and 500 white pine trees at Spot Pond, Tewksbury (near Lowell), Massachusetts, were found by the writer, on September 7, to be dead or in a dying condition. These trees averaged approximately 8 inches in diameter, breast high, and 30 feet in height, and were located in a bottomland where the ground is normally moist.

A deficiency of rainfall occurred during June, July, and August of 1.16 inches, 2.90 inches, and 2.50 inches, respectively, and it is believed that because of this the ground on which these trees were located became drier than usual. Their shallow root systems undoubtedly were affected by such changes in moisture, the trees being left in a weakened condition, and consequently they were attacked by bark beetles, principally *Ips calligraphus* Germ. and *I. grandicollis* Eich., which normally do not infest healthy trees.

The remaining trees in the stand surrounding these were apparently unaffected and unattacked. As their root systems would naturally be deeper and more extensive than those in the bottom land, they would be better able to withstand the decrease in available moisture.

During the summer of 1929 the southern pine beetle was unusually aggressive and there were several outbreaks in western North Carolina. Coincident with these outbreaks was a notable deficiency in rainfall.

One large outbreak of the southern pine beetle was located at Hot Springs, N. C. It occurred during September on a section of the French Broad Division of the Pisgah National Forest. In this instance 2,716 trees, mostly pitch pines, were found to be affected. The attack covered some 30 acres of land. Precipitation records for this general region revealed a deficiency of 0.46 inch for July and 2.82 inches for August. A tall, dominant tree had been struck by lightning in the latter part of July and it is believed that this had helped to attract beetles to the area, as about 100 pines were infested around this one soon after it had been injured. The increasing deficiency in rainfall during July and August quite probably affected the remaining trees, making the rapid spread of the beetles possible, because the brood which emerged from the group around the lightning-struck tree had attacked the trees on about 30 acres by October. Several other spot outbreaks of this beetle were found in this same general region.

Another infestation was reported from Richmond, Virginia, during the late summer months. A number of pine trees were said to be dead or in a dying condition in that vicinity. Here also a marked deficiency in rainfall was recorded. During July it amounted to 2.57 inches and in August to 2.01 inches.

No reports of bark beetle outbreaks were received from localities where such a deficiency did not occur.

Wind-Thrown and Lightning-Struck Trees Prove Attractive. In addition to these general outbreaks of the southern pine beetle, several instances were noted where wind-thrown and lightning-struck trees had served as a definite attraction for the beetles in drought-affected areas.

During September an outbreak of the southern pine beetle, which affected some 80 or 90 trees, was found centered about a recent blowdown, about 10 miles from Hot Springs, North Carolina, west of Mooneyham Branch in Tennessee. The storm-felled trees were infested as well as those surrounding them. Another similar instance was noted near Winston-Salem, North Carolina, where about 50 trees were affected. In the general region of both of these places there was a marked deficiency in rainfall. On September 28 a group attack of this beetle was located near Bent Creek, North Carolina. In this instance the beetles were attracted to 15 shortleaf pines on August 25 as the result of the skinning of one of the trees by a large, overmature scarlet oak which fell against it during a storm a few days previous to this date. The injured

tree was 10 inches in diameter breast high and about 50 feet in height. Some of the limbs were broken off and a portion of the bark bruised as the result of the oak tree falling against it. This injury undoubtedly resulted in the attraction of bark beetles to the surrounding 14 trees which ranged from 3 inches to 10 inches in diameter breast high and from 25 to 50 feet in height. When the infestation was discovered the brood had already matured and was ready to emerge in most of the trees; blue stain had extended to the heartwood and the foliage was almost brown.

A number of cases were noted near Asheville, North Carolina, which indicated an attraction of the southern pine beetle to lightning-struck trees. On August 1 the writer's attention was attracted to one of these trees by the fading foliage. It was a shortleaf pine 10 inches in diameter breast high and 35 feet in height. The lightning had not only split open the bark the entire length of the stem of this tree but also had exposed one of the main roots. At the time of discovery a maturing brood was found in it. Near this tree were two large and five small infested pines which had not been struck by lightning. The large trees were 12 inches in diameter breast high and 35 feet in height, and 9 inches in diameter breast high and 25 feet in height, respectively. All seven trees had been attacked as a result of the attraction of beetles toward the lightning-struck pine.

Two other lightning-struck trees were found infested by the southern pine beetle in this same general region, but they did not attract enough beetles to kill any of the trees surrounding them. Several additional records were obtained en route from Asheville, North Carolina, to Washington, D. C., during early October. Isolated infested trees or small spot infestations could be seen at intervals along the highway from Morgantown to Winston-Salem, North Carolina, in which general region there was a deficiency in rainfall. In 21 cases examined it was found that lightning had struck a tree, which in turn was attacked by the southern pine beetle. Usually from 2 to 10 surrounding pines were also attacked and killed as the result of this attraction.

THE THRIPS FACTOR IN ONION STERILITY[1]

By HELEN MONOSMITH PEARSON

ABSTRACT

Observations show that *Thrips tabaci* may be an important factor in producing onion sterility, since the insects may seriously damage the essential organs of the flowers.

Thrips tabaci is considered a serious pest in the growing of onion bulbs. It thrives on a number of crop plants; and that thrips may cause sterility has probably been noted frequently before. It is probably thrips to which such statements as the following refer: "Partial and entire degeneration of anthers, and sometimes of the entire flower," in sugar beets, "was often observed by the writer in material which harbored in the inflorescence axis or its lateral branches the encased larvae of insects." (Artschwager, 1927). But the extent and seriousness of the harm thrips do the seed industries, particularly the onion seed industry, does not seem to be realized.

SEVERITY OF THE ATTACKS. Most of the observations here recorded were made on inbred Australian Brown onions, a late blooming variety, although thrips-infested plants of several other varieties were also examined. In a badly infested flower head there may be half a dozen or more thrips feeding on every flower. Thrips infestation is much worse in late varieties, and in the later seed heads of early varieties, than in earlier ones. This is probably due to the thrips' shorter life cycles at higher temperatures, which allows them to increase more rapidly, and to the lowered moisture supply. Wardle, Simpson, and MacGill (1927) find that a moist soil, or one frequently wetted and allowed to cake on the surface, does not seem to be favorable to the soil-pupating larvae of *Thrips tabaci*. These authors note that differences in susceptibility of different plants and different parts of plants seem to be due to differences in thickness of the epidermal layer and in rate of growth, a vigorous fast-growing plant being able to keep ahead of the attack. This was strikingly illustrated in a greenhouse experiment with twenty Yellow Danvers Flat onions, a variety of medium growth rate, and three Italian Red onions, a variety which grows perhaps twice as fast and luxuriously as Yellow Danvers Flat. A severe thrips attack killed all of the former, but only somewhat checked the growth of the latter. In the seed plots in the field some plants seemed to be much more severely infested than

[1]This investigation was supported by the Truck Crops Division of the Branch of the College of Agriculture of the University of California at Davis, California.

others of the same variety receiving the same treatment. These usually appeared to be the less vigorous plants, perhaps weakened by disease.

STERILIZING EFFECTS. Wardle, Simpson, and MacGill (1927) have investigated the feeding habits of thrips. They find that thrips feed by gashing the outer wall of the epidermis with the mandible, inserting the mouthparts through the cut, and gashing the inner walls of the epidermis and walls of the subepidermal cells with the longer, protruded maxillary lacineae, then sucking the contents with the aid of a partial vacuum established within the mouth cone closely applied to the epidermis. Death of the affected cells and surrounding cells is probably due to this cutting and sucking, and not to any toxic salivary secretion.

Thrips gain admittance to very young buds of the onion, for they have frequently been sectioned in flower buds with the pollen mother cells still in prophases. Perhaps the thrips force their way between the healthy perianth segments, but more likely between segments partially killed by earlier feeding. Within the young buds the thrips do a great deal of harm to the immature stamens and pistils. Sections show numerous thrips lesions into the anther locule cavities—paths of dead cells extending through all of the wall layers. The suction seems to burst the tapetal cell membranes, for, unlike normal anthers which in prepared slides show no contents but microspores, such anthers are usually filled with a thick tapetal periplasmodium which appears to have been sucked towards the lesion. A thrips attack may be followed by death of all the anther contents and collapse of the anther cavity, or few to many of the microspores may hypertrophy and pack together, giving a parenchyma-like appearance, usually interspersed with masses of material from dead tapetal cells and microspores. A thrips, accustomed to sucking only a few cells at a time, must certainly be happy to tap a whole anther locule! Thrips frequently feed upon the styles and stigmas, probably rendering the latter partially or entirely unreceptive, depending upon the age at which they are attacked and the severity of the attack. Thrips can perhaps harm young ovaries directly, but not the thick-walled older ones. They cannot harm mature anthers because the pollen grains are independent when dry, and also because the endothecium has become very thick. Perhaps the thickened endothecium serves as a protection against thrips even for a short time before the anther fluid has disappeared.

Aside from sucking the essential organs directly, thrips may cause sterility by feeding on the flower pedicels. In badly thrips infested buds, although an anther itself may not be sucked, its tapetal layer may degenerate abnormally while the rest of the anther still looks normal.

Shrunken tapetal cells with dense, homogenous appearing cytoplasm may thus occur in locules with normal prophase pollen mother cells, dyads, tetrads or very young microspores, instead of the usual layer of large, vigorously growing, large-nucleated cells. Just how important these and the corresponding effects on the pistils are in causing sterility is difficult to ascertain, since some badly scarred pedicels may bear apparently normal stamens and pistils. It is safe to assume that extensive feeding on the pedicel of the young bud may cut off its food supply, if not directly, since the conducting elements lie fairly deep, indirectly by killing large sections of the small pedicels. Similarly, feeding on the filaments of immature stamens cuts off the food supplies of the developing anthers. A reliable index of thrips infestation is the number of eggs laid in the flower (they are laid just beneath the epidermis) since the parents must have been feeding near. However, two or three eggs may be laid in a single flower, even in its pedicel, which seems to be an especially favored place, without any obvious sterilizing effects. This is especially true of older buds, since the attack on these probably did not begin until at least the pollen grains were out of danger. Thrips cannot seriously injure the developing ovules after the eggs have been fertilized except by feeding on the flower pedicels.

CONTROL. Nicotine sulphate and whale oil soap is an effective spray for thrips, although scarcely practicable. An insect, *Triphleps tristicolor* White, slightly larger than the thrips, preys upon it. How important *Triphleps* is as a check upon the thrips population is not known. Thrips are held in check by cool, moist weather.

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INJURY TO SUGARCANE BY A SMALL WEEVIL

By J. W. INGRAM and T. E. HOLLOWAY, *Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

The newly discovered injury to sugarcane by a small weevil, *Anacentrus* sp., is described. The character of damage is the destruction of the eyes of sugarcane and also killing of the young plants.

As long ago as 1919 the larva of a small weevil was reported by Holloway and Loftin[1] as making small borings in old cane stubble. This had been determined by W. Dwight Pierce as *Limnobaris sp.* Recently, specimens have been determined by L. L. Buchanan as *Anacentrus sp.* Mr. Buchanan writes, "This species is undescribed in all probability, though quite closely related to *planiusculus* Csy." The adult of this cane weevil is dark brown in color and from 3½ to 4 mm. long and 1 mm. wide. The larva is white with an amber-colored head. The pupa is white until just prior to emergence, when it becomes slightly brown.

Holloway and Loftin reported no injury, but it appears that the weevil is becoming injurious, or else climatic or some other influences cause it to become more important at times. In 1925 there was a report from a plantation at Franklin, Louisiana, that this weevil was doing damage and it was said that the insect bored into the woody part of the young plants just at the point where they leave the planted seed cane, killing them. The stand was therefore reduced. In many cases, however, the cane sprouted again and the new sprouts were not killed. The present writers visited this plantation on July 8, but at that time the damage had ceased. Out of 1,800 acres, the planter stated that only about 10 acres were infested and that there was a loss of only about two acres. The weevil, therefore, was not regarded as seriously injurious.

In examinations of sugarcane fields made during the past winter and spring, it was found that the same weevil was doing damage to cane stubble in all fields examined and in some fields had been an important factor in reducing the stand of stubble cane. The weevil larvae made tunnels in the cane stubble resembling those of the sugarcane borer, except for their much smaller size. In some cases the stubble was riddled with tunnels and all eyes killed either directly by the weevil larvae or by the entrance of disease organisms into the tunnels. The weevil tunnels were found most often at the nodes and near the outer surface of the stalk. Often eyes were found which the weevil larva had

[1]Insects Attacking Sugar Cane in the United States, by T. E. Holloway and U. C. Loftin. Journal of Economic Entomology, 12, p. 448–450, 1919.

hollowed out, thus forming a chamber in which it pupated. The injury was as a rule heavier in second-year than in first-year stubble. Injury was rarely found in plant cane, and when this occurred larvae were found boring in the young plant near the place where it joined the mother seed cane.

The adult weevils appeared to be most numerous in soil surrounding the cane stubble, in August and September. Evidently eggs were laid in the stubble about this time. The first pupa was found in stubble on January 20. The first newly emerged adult weevil was found on February 10. Larvae were found in cane stubble all during the winter and as late as June 11. In examinations made of cane in first-year stubble fields in April, it was found that about 54 per cent of the eyes were dead. Of this percentage 13 per cent had been killed directly by the larvae. Judging from a small number of stubble examined in adjoining plots this year, weevil injury has been heavier in the varieties known as D. 74 and Louisiana Purple than in P. O. J. 213.

No control measures are known thus far, but in case the damage should continue, experiments in control will be conducted.

INSECT PESTS OF UPHOLSTERED FURNITURE

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ABSTRACT

Insects as pests of upholstered furniture have become much more destructive during the past few years. This seems to be the result of the increased sales of upholstered furniture covered with woolen fabrics and filled with vegetable or animal materials susceptible to insect attack. Psocids and the tobacco beetle, while annoying to the owner, seldom appear to affect seriously the appearance or usefulness of furniture. Carpet beetles are minor pests, except in the case of the furniture carpet beetle. This insect is capable of rendering furniture both unsightly and unusable by devouring hair and feather upholsterings and by feeding on the wool in covers. Clothes moths, more especially the webbing clothes moth, are the most destructive of all pests since they persistently attack woolen covers, are so widely distributed, and spread so easily.

Ten years ago the inquiries received by the Federal Bureau of Entomology relating to insects affecting upholstered furniture were exceedingly few. But today, and for several years past, a considerable volume of correspondence on this subject has developed from all parts of the country, indicating the widespread injury and interest these pests are causing. The losses due to insect attack upon furniture are still further evidenced by the complaints received, not only from the house-

wife but from the furniture manufacturer, the retailer and the warehouseman, and by the ever-increasing volume of business transacted by insect exterminators, dry cleaners, laundrymen, and household-goods warehousemen, who, in ever more extensive advertising campaigns, offer to the public fumigation and moth-proofing services.

It is no longer safe for furniture warehousemen to store upholstered furniture without safeguarding it from insect ravages during the storage period. All up-to-date storage houses are now "moth-conscious" and have installed fumigating vaults or special storage space in which furniture can be rid of insect infestations. Of course it has been the vogue for beautiful woolen covers and luxurious furniture that has given insects an increased field for activity. The average American home today contains a greater abundance of material upon which this group of pests can develop than ever before. Only a brief mention of the principal pests is made here.

Clothes Moths

The Webbing Clothes Moth (*Tineola biselliella* H.). The most destructive of furniture pests is the webbing clothes moth. Its attack upon mohair-covered upholstered furniture is costing the householder in this country an estimated half million dollars annually. The larvae feed not only on the outer surface between the rows of pile but also on the under side. In either case, the aesthetic value of the furniture is ruined. While the surface feeding can be prevented by constant watchfulness and by brushing the pile, the larvae beneath the covers may become very abundant before their presence is even suspected by a careful housewife. These hidden larvae are the ones which sever the pile threads where they pass beneath the foundation warp, thus causing the development of bare spots in mohair through the falling out of the cut threads when the covers are cleaned. The writers believe that about 90 per cent of the well-defined bare spots in mohair-covered furniture are the result of opportunities given the moth larvae, through faulty construction, to reach the underside of the covers.

Case-making Clothes Moth (*Tinea pellionella* L). While the case-making clothes moth is not so commonly reported as injuring upholstered furniture, it can be very destructive. It is most conspicuous as a pest of feather filled upholstery. Feather and down cushions are sometimes completely reduced to a mass of frass, dead insects and their cases, and feather quills.

Carpet Beetles

The Furniture Carpet Beetle (*Anthrenus vorax* Casey). The furniture carpet beetle has become a most serious and destructive pest of furniture upholstered in hair and feathers. First discovered some years ago in Washington at the White House in chairs from a European country, the insect is now widespread throughout the older residential sections of the city. It is found in furniture often in unbelievable numbers and when so abundant not only consumes all susceptible stuffings but turns its attention to the covers, the larvae eating holes in the warp and through these passing to the outside where they begin eating off the pile in every widening patches. The covers of badly infested pieces sag, becoming pileless and unsightly. The leather-covered and hair-filled furniture of the Capitol Building and of leading clubs and private houses of Washington have yielded excellent examples of advanced cases of infestation. Often the householder's attention is first directed to the species by the large number of larvae and adults found crawling about the room. Furniture, held in storage in Washington for some months was found, after shipment to Chicago in 1929, to be badly infested. Undoubtedly the furniture carpet beetle will become in time a widely distributed pest in America.

Black Carpet Beetle (*Attagenus piceus* Oliv.) and the Common Carpet Beetle (*Anthrenus scrophulariae* L.). These insects are found frequently in very small numbers in furniture, especially the black carpet beetle. Neither species seems destructive enough to warrant much attention. In one instance a leather-covered chair was found so badly infested that many small holes were eaten in the cover by escaping specimens.

Tow Bugs

A few years ago all insects affecting upholstered furniture were spoken of by the furniture trade as "tow-bugs." One was at a loss to know what insect was involved in litigation when it was discussed as a "tow-bug." Today, clothes moths and carpet beetles are no longer "tow-bugs," this appelation being reserved more strictly for insects that feed upon vegetable upholstering materials. Such materials consist mainly of flax tow, palm fiber, sea moss and Spanish moss. The most common "tow-bugs" are the common tobacco beetle, the psocids or book-lice and, more rarely, the drugstore beetle (*Sitodrepa panicea* L.).

The Tobacco Beetle (*Lasioderma serricorne* Fab.). This insect, so well known to the entomologist, plays a very important role as a furniture pest, particularly of furniture upholstered in flax tow or straw.

All infestations observed by the writers have been in furniture in which flax tow was used as part of the stuffing. Furniture in which other vegetable materials were used to the exclusion of flax tow have not become troubled with the tobacco beetle. Flax tow has the advantage of being much cheaper than other vegetable materials commonly used in furniture construction, and this fact will result in its continued use by many firms.

The inquiries and specimens received through the correspondence of the Federal Bureau of Entomology make it impossible for the writers to indicate any one region as more subject than others to tobacco beetle attack in furniture. Some firms, however, avoid the use of flax tow in furniture to be sold in certain areas where complaints have indicated that conditions are peculiarly favorable to tobacco beetle increase. Thus it is understood that certain regions of the Ohio and Mississippi Valleys have been black-listed because of the numerous tobacco beetle infestations reported by patrons of furniture houses.

An examination of the flax-tow upholstering of a chair brought out the fact that not a single small handful of the straw was free of infestation, and larvae in all stages were observed. The larvae feed directly upon the straw. Only rarely are the covers of the furniture eaten and then only for the purpose of making exit holes. It would seem that the larvae and adults which often swarm from furniture in great numbers are able to leave the furniture through openings about seams and about the springs. When unable to do this, they are capable of eating holes in covers.

Psocids. Psocids seem to do no harm to furniture but they do often develop to tremendous numbers in the vegetable upholstering material and, leaving the interior, crawl over the covers and woodwork and greatly annoy the owner. No furniture has been reported visibly damaged by their development, but the presence of these insects, so common everywhere, is sufficient cause for the many free fumigations given by the furniture dealer for the benefit of their customers.

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RECENT DEVELOPMENTS IN *TRICHOGRAMMA* PRODUCTION

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ABSTRACT

This is an account of the commercial production of *Trichogramma* during the season of 1930. Improved types of equipment are described. Parasitism by *Trichogramma* was obtained in complete darkness as well as in daylight.

In Orange County, California, during the spring and summer of 1930 there was established by private interests the first plant for the commercial production of *Trichogramma*. During the first months of operation the writer acted as technical advisor.

The production units were housed in one of the buildings of the County Insectary originally built for the mass production of the coccinellid, *Cryptolaemus montrouzieri*. That the building was available was due to the effectiveness of the newly introduced parasites of the citrophilus mealybug which made possible a decided reduction in beetle propagation.

The climate of the section in which the insectary is located is very favorable to the economical production of *Sitotroga cerealella*, the laboratory host of *Trichogramma*. It is generally temperate and humid throughout the year, so neither artificial heat nor artificial humidity are required.

Three rooms were fitted up for moth production, one for egg deposition and one for parasite propagation. Each moth room contained a set of twenty wooden trays filled with 8500 pounds of common white corn. A single tray measures inside 9 feet in length, 30 inches in width and 5 inches in depth. The total cost of one unit set up, exclusive of the corn, was about $200.00. Each unit consisted of two parallel stacks of

trays, 26 inches apart. The outer sides of the bottom trays rested on the floor, the inner sides on two parallel 2-inch planks each 12 inches wide and 9 feet long, set up edgewise. These planks were held in position by two shorter pieces 26 inches long, one at each end. The inner side of each tray was ⅛ inch lower than the other three sides, in order to permit emergence of the moths from the trays. The outer side of each tray was ¼ inch above the bottom of the tray and the opening thus formed was faced on the inner side with a 30 mesh screen. Air can, therefore, be forced through the crevice at the upper side, down through the grain and out of the crevice on the lower side.

As each tray is filled, all the corn above the level of the sides is scraped off so that the weight of the bin above is supported only by the sides and crosspieces of the bin below.

A cover is placed on the top tray of each stack. The covers are wide enough so that they come together over the space between the stacks forming a solid roof. To complete the enclosure long cloth is tacked and pasted over the ends. A cloth door (2 feet x 3 feet) is constructed at one end. In the other end an electric fan is placed in a circular hole cut in the cloth. This fan blows in cool humid air continuously.

A piece of 1 inch pipe 5 feet long placed on one side of the enclosure about 4 inches from the floor extends from mid-way of the enclosure through one of the end planks. A standard vacuum collecting hose is fastened to the inner end, the other end outside of the enclosure serves as a connection to a portable moth trap. This trap is made up of the following parts:

1. A cylindrical cage (8 inches x 20 inches) of 20 mesh brass screen with a removable cap on one end.

2. A cylindrical housing for the cage made of sheet iron. This housing is 10 inches in diameter and 24 inches in length. In the bottom is a 1¼ inch opening which forms the inner end of a pipe 2 inches long. The bottom is inset 3 inches so that the housing can be set upright when assembling the trap.

3. A coil of spring wire 3 inches in height and 4 inches in width.

4. A cover to the housing with a 1¼ inch pipe through its center and projecting 2 inches on either side. The inner side is faced with a soft rubber pad ½ inch thick.

In assembling the trap, the spring coil is placed on the bottom of the housing. The cage, with cover removed, is set on this spring and then the housing cover is placed on top. The cage is then forced down until the cover can be locked in position.

Trap in position for operation

Moth cage and housing

UNIV. OF MICH.

The spring presses the mouth of the cage against the rubber pad so that the moths cannot escape. The cage is in a horizontal position when in use. An electric motor and suction fan are attached to the pipe at the bottom end of the cage by a flexible tubing, a similar piece of tubing also connects the pipe on the housing cap to the outer end of the pipe leading into the moth enclosure.

When a sufficient number of moths are collected in the trap, it is set up on end, the cover unfastened and the cage vibrated on its spring to shake down the moths so that the cage cover can be placed on without losing any.

The cage containing the moths is then placed in another cylindrical housing for the deposition of eggs. This housing is 10 inches in diameter, 4 feet in length and open at each end. Two strips of sheet iron 1 inch wide and placed 3 inches apart extend the length of the tube These serve to hold the cage in the center of the cylinder when in a horizontal position. An electric fan is placed at one end and a baffle board and a trough at the other end to deflect the air current and concentrate the eggs deposited in the air current.

The eggs are then cleaned and placed on egg cards. In preparation for this, shellac is stamped on to the cards (4 inches x 8 inches) in small squares. A piece of birch wood grooved across and lengthwise to form a series of raised blocks is used as a stamp. The surface of this is coated with shellac and then pressed on to the cards. Eggs poured on to the card adhere on uniform squares facilitating the counting of the eggs and cutting of the card into small units for liberation

An infestation of *Sitotroga* was built up in the corn for a month prior to placing it in the bins. During the period of infestation the corn is kept at a temperature of 80°F. After being placed in the bins no artificial temperature is required, in fact it was necessary to reduce the heat of infestation by constantly circulating cool humid air through the corn. For mass production the optimum temperature is about 85°F.

During April and May, *Plodia interpunctella* became so numerous as to interfere somewhat with parasite production. It was practically impossible to segregate the *Sitotroga* adults from *Plodia* adults before placing them in the egg deposition cages, or their eggs before placing them on the egg cards. The larvae from unparasitized *Plodia* eggs fed on the parasitized eggs and spun a dense webbing over the entire mass. This trouble was entirely eliminated by the introduction of *Habrobracon juglandis* into the moth rooms. This parasite increased rapidly until *Plodia* larvae were rarely seen on the egg cards. In this connection it is interesting to note the peculiar oviposition habit of *Plodia*. The female

appears to prefer to deposit its eggs on single strands of silk stretched across crevices and between kernels of corn. They then have the appearance of beads on a string. The *Ephestia cautella* has a similar habit.

The first unit was filled with corn May 4. Ten days later the egg production amounted to 100,000 daily. On May 30 it reached 200,000. During June, July and August the production from this set averaged over 500,000 eggs daily. The second unit reached full production June 23. The third unit began producing moths abundantly the first of July. About the middle of August, however, a parasite of the larvae of *Sitotroga* was noticed in considerable numbers in this set. It increased so rapidly that by the end of the month production had declined to practically nothing. All three units were finally invaded and production ceased.

This parasite was identified by Gahan as *Habrocytus cerealellae*. It also oviposits in the cocoons of the potato tuber moth larvae. The incubation period of the egg at 80° F. is less than 24 hours. The invasion of this parasite emphasizes the fact that insect proof insectaries are necessary for work of this type.

The type of cage used for obtaining parasitism is a wooden box with one side of glass so constructed that when in use no light can enter or parasites escape. The box measures inside 4 inches in height, 8 inches in width and 16 inches in length. Two of the sides (4 inches x 16 inches) are fastened on with clamps. One serves as a door and the other to cut off light entering through the glass wall opposite. The inner surface of the top and bottom are grooved $\frac{5}{8}$ inch apart, each groove wide and deep enough to hold two egg cards back to back. When loaded to full capacity it holds over 2,000,000 eggs.

In loading the box it is placed so that the glass side is toward the source of strongest light, the sides are then removed and a strong current of air is directed across the opening to prevent the escape of the parasites. The used stock cards and newly parasitized cards are then removed and replaced with a new supply.

When large quantities of eggs are to be parasitized in such a container, it is preferable to have the parasites emerge from the stock cards as soon as they are placed in position. Wishart first made use of the retarding effect of darkness and cooler temperatures on the emerging parasites in order to obtain complete emergence within a short period. Light is admitted to the box until practically all the parasites have emerged.

Light entering a container from one direction apparently interferes to some extent with oviposition of certain strains.

When the temperature of the parasite room is maintained at about 80° F., the parasites commence to emerge seven or eight days after oviposition, depending on the strain used. The emergence can be delayed nine days by placing the parasites in a constant temperature of 53°F. one day before they are due to emerge at 80° F.

For several weeks during July and August, the number of parasites produced daily at the Orange County laboratory amounted to well over 1,000,000. The total number shipped out for liberation in the field up to the first of September was over 20,000,000. It is estimated from the number of eggs in storage and parasites on hand that 10,000,000 will be available for shipment during the first two weeks of September.

For experimental work the writer devised a simple type of unit, which consists of a cone 8 feet in diameter made of 18 gauge galvanized sheet iron. It is made in two sections and is fastened together with bolts and wing-nuts. At the apex is an aperture 6 inches in diameter. This forms an opening for filling the cone with corn and for the emergence of the moths.

The sides of the cone form an angle of 22.5° with the horizontal. At this slope there is no flow of corn and the entire cone can be raised about ⅛ inch. There is then sufficient space over the entire surface of the mass of corn to allow the newly emerged moths to crawl upward toward the exit. The lower edge of the cone can be banked with sand to prevent any moths from escaping.

In order to trap the moths, a cylindrical cage (6 inches x 12 inches) made of 20 mesh brass screen is placed over the aperture at the apex. The cover of the cage is made of tin and is an interiorly directed cone having sides sloping at the same angle as those of the larger cone. At the apex of the cover is a ¼ inch aperture through which the moths enter the cage. A tin disk 2 inches in diameter is fastened to the apex so that the aperture is at its center. This disk decreases the chances of the moths reentering the cone. When the trap is inverted and placed in position its cover is just large enough to fit over the 6 inch aperture of the large cone containing the corn. A ring of clay or putty at the edge of this aperture can be used as a base on which to place the trap so that moths cannot escape.

This unit is rendered useless for *Sitotroga* production if *Plodia* larvae are present, since they spin a dense webbing over the aperture of the cone.

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OBSERVATIONS ON THE "YELLOWS" DISEASE OF BEANS AND RELATED PLANTS IN HAITI

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ABSTRACT

A disease of beans resembling a mosaic but named a "yellows" disease of serious importance in the low lands was found to be transmitted by a new species of *Empoasca* leaf hopper. No other insects transmitted the disease during these studies. There was considerable varietal difference in susceptibility and loss observed, the Lima bean group of which Jackson Wonder was particularly studied being able to mature a fair crop in spite of the disease. The paper records also historical observations, experiments to determine the relation of various insects to the disease, inoculation tests, possible inheritance through the seed and control experiments with Bordeaux mixture and nicotine sulphate, both failing to control either the leaf hoppers or the disease.

For several years the Department of Plant Pathology has observed the presence of a very severe bean disease and has recorded it as Bean Mosiac.[1] However, certain peculiarities were observed which aroused doubt as to the identity of this malady. For example, in the summer of 1926, an outbreak at Thor, near Port-au-Prince, on cow peas following a heavy infestation of leaf hoppers was observed, the progress of which appeared to be arrested somewhat by spraying with Bordeaux mixture, altho no control plots were left unsprayed. Similar outbreaks during the same season occurred in the horticultural plots on cow peas which had been severely infested with leaf hoppers.

Numerous observations at Damien, Haiti, appeared to indicate a relationship of the disease to leaf hoppers. Furthermore, repeated search had not revealed the presence of any aphids, some species of which are considered to be carriers of mosaic. The known relation of certain species of leaf hoppers to alfalfa yellows and aster yellows pointed to the possibility of a similar condition with beans. Wolcott (1923) quoted from four authors who mentioned similar if not identical injury to beans and cow peas by *Empoasca mali* L. B. in Porto-Rico.[2] Consequently, early in 1929, experiments testing the possible relationship of the bean leaf hopper of Haiti to the so-called mosaic disease of beans and related plants were begun.

ECONOMIC CONSIDERATIONS. The disease is very general in Haiti, occurring wherever beans are grown. There are, however, some peculiar seasonal and topographical modifications. In the low lands or plains

[1]Annual Report of the Service Technique, 1924–25, p. 90.

[2]Wolcott: Insectae Portoricensis, Jour. Dept. Agr., Porto-Rico, –7, No. 1, p. 269. *E. mali* L. B. equals *E. flavescens* Fabr. according to De Long.

susceptible varieties cannot be grown during the summer months (April to Oct.) whereas in the winter months (Dec. to March) such varieties are ordinarily little damaged by the disease. But in the mountainous regions, at an altitude of 2,500 ft. or more, very susceptible varieties can be grown during the summer season without much or any loss from the disease. For example, the Plant Disease Survey recorded in July, 1924 a large field of "Pois rouge" on the Pineapple plantation at Cap-Haitien completely destroyed by the disease, whereas on the same date this variety was fruiting well with little damage on top of Pilsboro mountain at an altitude of about 3,000 ft. Therefore, it may be said that this disease limits the production of beans in Haiti to a very short season, except for localities of high elevation. Since beans constitute one of the most important native foods, the problem is of fundamental importance. It is probably important also in neighboring islands.

NATURE OF THE DISEASE. In planning and conducting these experiments the authors were unable to find any clear references to this particular disease in the literature available. Beyer (1922) described one or more diseases which he calls "hopperburn,"[3] but the descriptions are not sufficiently clear to establish the identity of those diseases with the "yellows" of beans in Haiti, altho it appears probable from the illustrations on page 68 and 99 of his report that this disease was involved. However, his description of hopperburn which follows does not correspond to the symptoms commonly manifested under Haitian conditions.

"The tender surfaces of the leaves and stems are penetrated, and as a result of the loss of juices the plants take on a yellowish appearance. The next injury to appear is called tipburn or hopperburn which starts with a slight yellowing often at the tip of the leaf, and as the injury progresses along the margin of the leaf the color turns to a dark brown and the leaf begins to curl upward at its apex... This trouble is identical with that which Dr. Ball described as occurring on potatoes."

In Haiti, the disease generally takes the appearance of a "typical" mosaic disease, and does not suggest the tipburn or hopperburn of potatoes. However, the symptoms vary so widely with different varieties that a generalized description might be misleading. Discussion therefore will be reserved for remarks under varietal differences. However, the plants of all varieties were appreciably stunted by the disease.

[3]A. H. Beyer, The Bean Leaf Hopper and Hopperburn with Methods of Control, Fla. Agr. Exp. Sta., Bul. 164, 1922.

This was more marked if the disease developed early. Climbing varieties are reduced practically to bunched plants, while if protected in the cages, they exhibited the normal climbing tendencies. The amount of bloom was reduced in all varieties which in turn reduced the yield correspondingly. The name "hopperburn" is not regarded as appropriate for this disease, since there is no burning or drying of foliage, except in the last stages, but a yellowing occurs instead, so the term "yellows" is here used. This designation is in harmony with aster yellows, alfalfa yellows, and other diseases that have been grouped under this appellation.

METHODS EMPLOYED IN THE EXPERIMENT. The purposes of the experiments were to determine any possible relationship of the bean leafhopper of Haiti (determined by Dr. D. M. De Long as a new species of *Empoasca*)[4] and other insects to the disease, the nature of the disease and methods of control. The following experiments were conducted:

a. Series of beans were grown in very fine mesh, insect proof, wire cloth cages (Pl. 32, fig. 1) and compared with the same varieties planted at the same time in the open.

b. Various insects were separately introduced at various stages of the growth of the beans and results noted.

c. The effects of environmental conditions such as partial and complete shade were studied.

d. Possible transmission by means of seed from diseased plants was tested.

e. Varietal differences in susceptibility were studied.

f. Artificial inoculations were made on healthy plants with the juice from diseased plants.

g. Spraying with Bordeaux mixture and Nicotine sulphate as control measures.

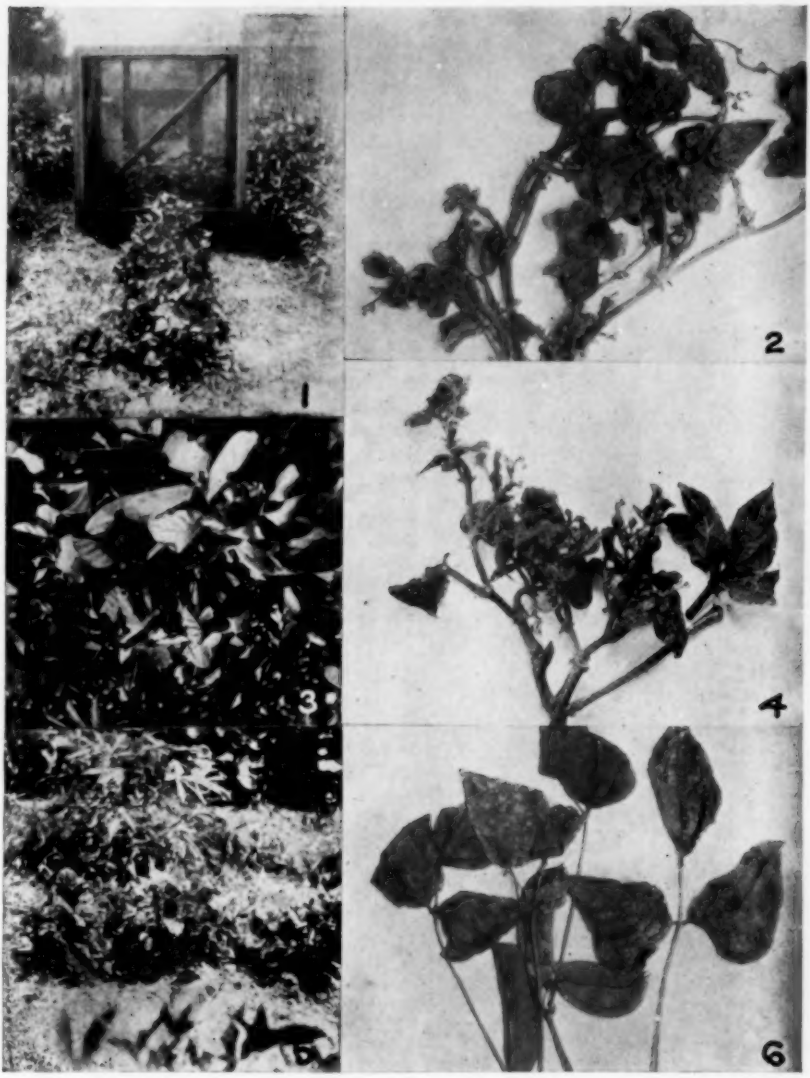
DISCUSSION OF RESULTS OBTAINED

a & b. Repeated tests with three varieties, Black Valentine, Jackson Wonder and Kentucky Wonder, the seeds of which had been purchased from the Reuter Seed Co. of New Orleans, failed to develop the disease during 1929 on beans grown in insect proof screened cages (Pl. 32, fig. 1).

Three small cages were placed inside the large screened cage containing disease-free plants approaching the blooming stage. In the first study 77 specimens of the common bean leaf hopper, *Empoasca* sp. were placed in one cage. In the second were added all other kinds of insects collected from neighboring beans. No insects were placed in the third which was left as a check for the effects of double shading.

In the first cage the disease began to be apparent on the fifth day after the introduction of Empoasca leaf hoppers. All of the cages were,

[4]Described as *Empoasca fabalis* n. sp. DeLong: A New Species of Bean Leafhopper from Haiti. Can. Ent. 62: 92–93, 1930.



1, Jackson Wonder Beans being grown both in a leaf hopper proof cage and in the open. Those outside are seriously affected by the yellows disease; 2, A twig of Kentucky Wonder beans showing the dwarfed, discolored, and distorted membrane accompanying the yellow diseases; 3, A large native bean, "Pois maldioc" showing the discoloration presumably of this disease; 4, Red bean twigs, (Pois rouge of Haiti) showing marked dwarfing and curling as occurs in susceptible varieties due to the yellows disease; 5, Kentucky Wonder beans growing in the open heavily infested with *Empoasca* and seriously affected by the yellows disease; 6, Jackson Wonder foliage and pods showing yellows disease on both. Note the difference in effect on the foliage in different varieties by comparison with Figs. 2 and 4.

however, left for several days for observing further developments. The disease progressed very rapidly in the first cage, whereas not the slightest symptom appeared in the second and third small cages or on the other beans in the large outer cage. These experiments were repeated in July and August with the same results. Bean aphids, other bean leaf hoppers, bean leaf beetles and bean red spiders failed to transmit the disease in these experiments.

The *Empoasca* leaf hoppers used in these experiments were collected from neighboring beans, many of which were badly affected by the "yellows." It would be desirable to know whether this species of leaf hoppers would transmit or induce the disease if they had never fed on plants showing symptoms of this disease, but this species of Empoasca could not be found except on garden plants, and beans were always nearby.

c. The effects of environmental conditions, such as the winter season and high altitudes has been mentioned in the discussion of economic considerations. It is thought that such effects might be a response to lower temperature. Facilities for artificially controlling the temperature were not available. However, the effects of partial and complete shading were tested.

The shade provided by double cages of very fine mesh brass cloth did not inhibit the development of the disease in the experiments described above. Likewise beans grown in the lath house and under the partial shade of interplanted crops, such as cotton and manioc, appeared to exert no inhibiting influence.

Plants under complete shade naturally became anemic and made no development except near the margin of the shaded areas, where the disease developed as severely as on non-shaded plants.

d. During the month of June seed procured from very severely diseased plants was planted and grown under cages as described above. They produced normal healthy plants, whereas seed planted in the open became diseased very soon after the young plants emerged from the soil. This experiment was repeated a few weeks later with the same results which clearly indicated that the disease was not seed borne.

e. *Varietal susceptibility.* Forty-two varieties of beans, several varieties of peas and related plants were tested for varietal susceptibility during the month of August. Included therein were the most common varieties obtainable from well known seed houses as well as the native grown "Pois rouge" and "Pois maldioc" (*Canavalia ensiformis*).

Ten days after planting, seven of the bean varieties showed unmistakable symptoms of the disease. Within a period of ten days more, practically all of the common beans had become affected. Very marked differences in varietal susceptibility were apparent, ranging from complete susceptibility as shown by the death of the plants shortly after the seedling stage, to a very high tolerance of certain varieties which produced a moderate yield of pods.

Of the common bean (*Phaseolus* spp.) Henderson's Bush Lima and Jackson Wonder proved the most resistant of the varieties tested. The common "Pois rouge" of Haiti was very susceptible, altho it was not

killed quite so readily as Black Valentine. The common cow pea of Haiti has been found to be sufficiently resistant so that it can be grown with fair results on the low lands during the summer season. A few cases have been observed where considerable areas have been markedly stunted following unusually heavy infestations of the Empoasca leaf hoppers. Velvet beans show distinct symptoms of the disease without however suffering any apparent deleterious effects. "Pois Maldioc" was almost immune to the disease, only a small proportion of the plants showing any distinguishable symptoms (Pl. 32, fig. 3) and marked stunting effects were not apparent on any great number of such affected plants, except when attacked at an early stage of growth.

The symptoms varied markedly on different varieties and species of plants. The first manifestations were usually a curling of the leaves downward, generally accompanied by a slight yellowing at the margin of the leaves. As the disease progressed, the yellowing became more pronounced. In some varieties the veins and petioles became yellow while the intervening leaf tissue was still green; in other varieties the veins and petioles were the last portions of the leaf to become yellowed; in other varieties the leaves became almost white and the plant rapidly assumed an anemic condition rather than the typically dwarfed, "mosaic" appearance.

In very susceptible varieties necrosis rapidly followed, progressing variously in the different varieties. Jackson Wonder and Henderson's Bush Lima showed yellow mottled areas with little necrosis following, but stunting effects were quite apparent (Pl. 32, fig. 4). It appeared likely that a yellow condition of adjacent peanuts infested with the same leaf hoppers was related to the bean yellows.

In summarizing the symptoms, it appears that a yellowing, whatever may be its extent or distribution in the leaves, is a general symptom. Marked necrosis (tipburn or hopperburn symptoms) is not common except in very susceptible varieties; leaves may or may not be crinkled and distorted. The leaves of Jackson Wonder (Pl. 32, figs. 1, 6) show the least curling of any variety, but other varieties show less curling when grown in the shade than when grown in the sun.

f. Experiments were made to test the possibility of artificially transmitting the disease from badly affected plants to healthy plants growing in wire cloth cages. Juice from diseased foliage was injected into wounds in the stems near the growing point and into the leaves and petioles. Repeated experiments gave negative results.

g. *Control experiments* After demonstrating the relationship of the small green bean leaf hopper, *Empoasca* sp. to bean yellows, it was thought that spraying with Bordeaux mixture might be an effective preventive of the disease.

Three attempts have been made to do this but in no case was yellows prevented. However, the earlier spraying operations were open to some criticism, since in the first attempt, the first spraying was delayed until the beans had already been fed upon by leaf hoppers and in the second, the interval between sprayings was occasionally too great. Final tests in March 1930, in which a plot of "red beans" was sprayed

weekly with Bordeaux mixture 4–8–50 and a similar plot was sprayed at the same time with Nicotine sulphate, 1 teaspoonful to a gallon of water, were unsuccessful as control measures in both cases. The nicotine plot had approximately the same numbers of leaf hoppers and "yellows" as the check plot had. The Bordeaux sprayings reduced the numbers of leaf hoppers and the amount of "yellows" somewhat, but not to the point of control. We have, therefore, been unsuccessful in all attempts at controlling the leaf hoppers and the disease by spraying. Selection for resistance probably offers the best promise in Haiti.

CONCLUSIONS. We conclude from these observations:

1. That the bean yellows disease described herein on various varieties of beans and several related plants in Haiti, is caused by the feeding of a small green leaf hopper, *Empoasca* sp. Whether this disease is a virus transmitted by the leaf hopper, or whether it is a reaction from certain fluid injected while feeding, was not determined, because no leaf hoppers which were definitely known not to have fed previously on beans could be obtained;

2. That no other insects occurring on beans during these studies caused the yellows disease to develop;

3. That the disease can be induced on healthy plants at any stage by merely lifting the cages and exposing them to the leaf hoppers or by placing leaf hoppers of this species on the beans;

4. That the disease is not transmitted through the seed. Beans grown from the seed of plants seriously affected, if kept free from leaf hoppers, produce normal plants at any season without signs of the disease;

5. That the disease was not transmissible through ordinary plant pathological inoculation procedure;

6. That all varieties of beans are attacked, but marked differences occur in varietal susceptibility ranging from complete susceptibility as evidenced by early death to a high degree of resistance with the production of a moderate crop. The Lima bean group belongs to the latter category; and

7. That control by spraying with Bordeaux mixture and nicotine sulphate was not obtained and if prevention of the disease is possible at all it will likely be difficult.

PETROLEUM INSECTICIDES

By C. W. Woodworth, *Berkeley, Calif.*

Kerosene emulsion was for a long time the standard, and almost the sole, insecticide, of this class. Heavy oils had been used in a small way in California and elsewhere for many years, but remained of minor importance and were not safe on foliage. My former student and assistant, Mr. W. H. Volck, introduced the highly refined heavy oils which, during the last few years, have sprung into such prominence, being now produced in large quantities by more than a score of manufacturers. Only the arsenicals have now a larger place and the prospect is that the heavy oils will shortly become the chief of the insecticides.

The heavy oils really constitute a new insecticide strikingly different in most particulars from kerosene as is shown in the following table which points out the more striking characteristics of the leading classes of insecticides arranged according to their economic standing, except that kerosene should be at the end of the list instead of next to the heavy oils where it was placed to bring out more clearly the differences between the two types of petroleums.

Chief Classes of Insecticides

	Arsenicals	Heavy oils	Kerosene	Sulphur	Cyanide	Nicotine
Toxicity:						
General	x	–	x	–	–	–
Selective	–	x	–	x	x	x
Nature of Poison:						
Nerve	x	–	x	–	x	x
Systemic	–	x	–	x	–	–
Place of Absorption:						
Stomach	x	–	–	–	–	–
Tracheae	–	x	x	x	x	x
Recovery by:						
Crisis	–	–	x	–	x	x
Lysis	x	x	–	x	–	–

The distinctions made in the above table are not rigorously true since there are differences of susceptibility even in the case of such a general poison as an arsenical and likewise in every other item of the table the distinctions are relative rather than exclusive, tho' expressing real and important differences. It is to be expected that presently there will be available heavy oils that differ strikingly from the characteristics indicated in the table, because the possibilities of this type of insecticide is still largely an unexplored field. We may expect the development of a family of petroleum insecticides, including the present kerosene and heavy oil with intermediate members and others different from both.

There are over a hundred brands of heavy oils now on the market, but these do not represent many distinct types and there is considerable variation in the oils selected for the manufacture of some of the commercial brands. The control laboratories generally distinguish the (1) *miscible oils* made with a cresol soap; (2) *the soap emulsions* made with ordinary soaps; and (3) the *non-soap emulsions*, the most common emulsifier being an alkaline caseinate. The more important distinction, however, is the character of the oil employed. The three types are (1) the *Kerosenes* with gravity of about 40° Baume, constituting probably not over 2% of the trade; (2) *Summer oils* with a gravity about 30° and (3) the *Crude* and *Winter* oils with a gravity around 20°. The crude oils consist of a mixture of oils having a wide range of gravity, while those sold as winter oils are distillates in which both the lighter and heavier fractions have been removed and some of them approach the summer oils both in gravity and refinement.

Manufacturers commonly classify their summer oils as *heavy*, *medium*, and *light*, following the practice of the lubricating oil trade for oils of similar viscosities. These terms are completely misnomers, since those denominated *heavy* and *light* may have precisely the same gravity. There is no reason for entomologists to perpetuate this inaccuracy and the terms *thick* and *thin* are introduced as substitutes for heavy and light.

The following table gives in round numbers the average physical characteristics of the winter oils and three grades of summer oils compiled from the data published during the last two years by the California State Department of Agriculture:

Type	Gravity Baume	Viscosity Saybolt	Sulfonation	Distillation 350°—325°		Evaporation 24h	6h	2h
Winter oil.....	22°	110 sec.	68%	40%	15%	——	——	——
Thick oil.....	29°	110 sec.	97%	30%	10%	55%	35%	20%
Medium oil.....	30°	80 sec.	95%	50%	20%	65%	45%	30%
Thin oil.....	31°	60 sec.	93%	75%	25%	85%	60%	40%

It is quite conceivable that not one of the physical data shown in the table above, by which we now strive to characterise and differentiate between these oils has any real significance in determining their efficiency as insecticides. We only know that California petroleums with quite an amount of variation in their physical characteristics exhibit a remarkable efficiency. It is in this State that the large use of these oils originated and where they have been most thoroughly tested. Whether oils produced in a similar manner from crude oils with a paraffin base will show similar characteristics to our asphalt base oils has not been sufficiently demonstrated.

The insecticidal effect of an oil depends on the very small quantity of the material that is absorbed by the blood after finding its way into the tracheae of the insect. This absorbable ingredient may be very small in amount, but is the essential element and it may be that all of the measured physical qualities merely indicate the character of the predominating non-absorbable, and therefore non-effective, portion of the oil, the menstrum in which the effective biolyte is dissolved.

The amount of oil that penetrates a leaf is probably much greater relatively than that which enters an insect and the effects on a plant are also easier to study. The following is an attempt to organize our knowledge concerning oils and plants:

Tentative Classification of the Oil Effects on Plants

Mechanical—increasing with high viscosity and low evaporation

1. Softening of the bark and bud scales
2. Changing appearance of fruit with bloom
3. Reduction of cuticular evaporation, giving protection from desiccating winds (after initial chemical effect is past).
4. After the penetration of the walls of the guard cells, there may be excessive evaporation through the stomata.

Chemical—depending on the chemical ingredients of the oil. These are grouped in three series:

Paraffins—Lower members of the series are more general poisons. The higher members are practically inactive and in the heavy spray oils now on the market constitute only the menstrum carrying the unsaturates of the following series.

Olefins aromatics—Many of the higher members are special drugs or poisons and much more active.

There is a very slow translocation even of the denser oils and consequently a slight physiological effect, but the nature of the more evident actions consists in:

(A) Modification of the action of certain *enzymes:*

1. Increasing hydrolysis, initial and local—
   (a) dropping of leaves and fruit; afterward the general effect is—
   (b) growth stimulation; reduction of quantity of fruit buds, and
   (c) early opening of buds in the spring (See also 1 under *Mechanical* effect);
2. Decreasing oxidation, thus delaying—
   (a) ripening of fruit;
   (b) coloring of lemons; and
   (c) coloring of autumn leaves.

(B) Biolysis of the *protoplasm*, followed by excessive oxidation showing as:
   (a) browning of the leaves or parts of leaves or fruits;
   (b) dying of tips of twigs; and
   (c) death of spots on roots or bark.

This class, with the common end points just enumerated above, can be subdivided according to preliminary symptoms indicating differences of the chemical action of the biolytes.

Hastening conditions:
- Low viscosity permitting rapid penetration.
- High temperature producing low viscosity in the oil.
- Dry condition of leaves permitting ready penetration.
- Quick breaking of the emulsion.

Intensifying conditions:
- Slow evaporation giving a long time for penetration.
- Low temperature reducing the rate of evaporation.
- High concentration of spray.
- Special susceptibility of the plant.

The terms *biolysis* and *biolyte* used above are, I believe, new in entomological literature. These words in their various forms will prove very useful; thus, *biolyte* is the general term for insecticides, fungicides, etc., *biolysis* is the killing of pests, and the science of economic poisons is *biolytology*. When studying the nature of biolytes, it will commonly be desirable to employ lower concentrations reducing a biolyte to a biostroph. Most of the items in the above classification are biostrophic and they are by no means all injurious.

Petroleum oils open to us a new and very difficult field for research, but one which promises more at the present time for the advancement of economic entomology and of the whole subject of biolytology than any other. It involves the most thorough-going investigation of the biastrophic action of the almost innumerable hydrocarbon compounds found in petroleum oils, either in nature or after synthetic manipulations. This study must be made on all classes of living organisms. Out of this study we may expect the emergence of a series of biolytes better than we now have and perhaps sufficient to meet all the needs of pest control.

The control laboratories have thus far assumed that physical or chemical determinations are adequate to measure the biolytic value of spray material, but they are certain to be forced by the development of organic biolytes to turn to methods of making tests on living organisms, for many of these biolytes may prove to be as elusive as are the vitamines.

EXPERIMENTS WITH INSECTICIDES AGAINST CATTLE GRUBS, *HYPODERMA* SPP.

By F. C. BISHOPP, E. W. LAAKE, R. W. WELLS, and H. S. PETERS,[1] *Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

Results are presented of tests of single and repeated applications of various insecticides against cattle grubs, *Hypoderma* spp., when applied to the backs of cattle. These supplement similar tests reported in an earlier publication. Special attention was given to the use of insecticides in dust form. Ground derris root and carriers containing derris extract were tried under varying conditions, and excellent results were obtained, Tobacco powders and dusts containing free nicotine and nicotine sulphate were also extensively used and gave a high degree of control.

An increased realization of the heavy losses which are being sustained in many parts of the world from the attacks of cattle grubs, *Hypoderma lineatum* De Villers and *Hypoderma bovis* DeGeer, makes desirable more extensive investigations of these insects and of various methods of combating them. Work thus far accomplished indicates that the most practical control measures are those directed against the larval stages in the cysts beneath the skin of the backs of the cattle, since here the insect is most accessible to attack.

Hand extraction is a comparatively simple operation in some cases and is being rather extensively practiced, but it has distinct limitations. In the first place, it is disagreeable work and the cattle are more or less restless and excited during the ordeal. In the second place, in the case of certain breeds and individuals it is very difficult to remove the grubs without the use of forceps; and in the third place, there is danger, especially in the case of animals from which extraction is difficult, that abscesses will be induced by the crushing of the larvae or the bruising of the tissues, or that the proteins in the bodies of the grubs, entering the general circulation in large quantities, may produce anaphylaxis.

These objections are largely met by the application of insecticides to the backs of the cattle. In Europe as well as in this country marked interest has been shown in recent years in such treatment for the control of cattle grubs. There seems to be a tendency, however, in European countries to turn to patented mixtures rather than to develop simple insecticides which are readily available and not controlled by proprietary interests.

[1]The following members of the staff of the Bureau of Entomology have aided materially: W. G. Bruce, H. M. Brundrett, E. C. Cushing, D. G. Hall, J. F. Krueger, J. L. Webb, and also Mr. C. C. Compton of the Office of the State Entomologist of Illinois.

The Insecticide Division of the Bureau of Chemistry and Soils cooperated by making analyses of several of the insecticides used and by preparing the rotenone dusts.

METHODS OF PROCEDURE. The experiments reported upon in this paper were conducted in New York, Texas, and Vermont during the years 1925 to 1929, inclusive, on dairy cattle, mainly of the Jersey and Holstein breeds. The treatments were applied in barns, and in most cases the cattle were kept in the open except during milking hours. These experiments supplement those presented in 1926,[2] and, as in the tests reported therein, have been carried out under widely varying conditions as regards breed, age, and condition of host, climate, housing, etc. The methods of procedure in applying the treatments and in recording the results, however, have been made as nearly uniform as possible.

TESTS OF SINGLE APPLICATIONS OF INSECTICIDES AFTER DETERMINING THE INSTAR OF EACH GRUB. To obtain exact information on the toxicity of various materials to cattle grubs in each accessible stage of development and to make the data comparable with similar information reported on pages 94–97 of Department Bulletin 1369 (see footnote 2), tests of a number of materials were made on grubs, the instars being determined immediately before treatment. The infested cattle were first numbered individually and the location of each grub was then indicated on a diagram of the back of each animal. Each grub was marked by clipping a lock of hair from the animal a short distance below it. The stage of development was then determined with little disturbance of the grub, and the insecticide carefully applied to each grub hole. To determine the larval instars it is often necessary to clean out the openings in the skin of the cattle. This also allows the grubs to be reached more easily by the insecticide, and greater efficiency is obtained than under practical conditions where these openings are not cleared. Five or six days after treatment the grubs were carefully removed from the cysts and their condition determined. A small percentage of the grubs found alive at the time of examination would probably die later as shown in other tests. The major effects could best be determined, therefore, at that interval after treatment.

The results of these tests are presented in Table 1. At the time of checking results some of the grubs that had not been killed had matured and escaped. Others which had been killed may have been expelled. These are accounted for in the column headed, "Number of grubs not found." It will be noted that more grubs had disappeared in the case of treatments with materials of low toxicity than with those of high toxicity. This was to be expected, as, naturally, some of the injured

[2]Bishopp, F. C., Laake, E. W., Brundrett, H. M., and Wells, R. W. The Cattle Grubs, or Ox Warbles; Their Biologies and Suggestions for Control. Dept. Bull. 1369, U. S. Dept. of Agr., 119 p.

TABLE 1. TESTS OF INSECTICIDES AGAINST HYPODERMA SPP. IN BACKS OF CATTLE—SINGLE APPLICATION AFTER DETERMINING INSTAR OF GRUBS

Item No.	Material and strength used	Number of cattle treated	Number of grubs treated	Number of grubs dead Instar 3	4	5	Number of grubs alive Instar 3	4	5	Number of grubs not found	Per cent dead based on dead and alive only (excluding grubs not found)	Per cent dead based on all grubs treated: If all grubs not found are considered as dead	If all grubs not found are considered as alive
1	Cube root, powdered, 100-mesh, per cent rotenone unknown	11	116	0	40	76	0	0	0	0	100	100	100
2	Derris root, powdered, per cent rotenone unknown	9	115	0	22	92	0	0	1	0	99.1	99.1	99.1
3	Derris root, powdered, 0.5 per cent rotenone	56	204	0	26	152	0	4	22	0	87.2	87.3	87.3
4	Derris root, powdered, 1.35 per cent rotenone	76	301	0	14	210	0	4	55	18	79.1	80.4	74.4
5	Derris root, powdered, 2.3 per cent rotenone	38	251	2	28	146	0	29	46	0	70.1	70.1	70.1
6	Derris tailings, per cent rotenone unknown	22	88	0	14	37	0	8	29	0	57.9	58.0	58.0
7	Derris powder from which rotenone has been extracted with ether	18	80	0	0	22	0	1	44	13	32.8	43.8	27.5
8	Derris extract, 1 per cent rotenone (pure) in kaolin	20	111	0	4	78	0	1	21	7	78.8	80.2	73.9
9	Derris extract, 2 per cent rotenone (pure) in kaolin	24	156	0	24	108	0	1	1	2	98.5	98.5	97.1
10	Derris extract, 2.3 per cent rotenone (pure) in kaolin	18	107	0	8	99	0	0	0	0	100.	100.	10.2
11	Derris extract, 2.4 per cent crude rotenone in kaolin	23	141	13	69	24	2	27	6	0	75.2	75.2	75.0
12	Derris extract, 10 per cent crude rotenone in kaolin.	18	220	9	99	107	0	4	1	0	97.7	97.7	97.7
13	Derris extract ointment, 1 per cent derris resins plus other ingredients (proprietary)	24	226	0	70	150	0	1	3	2	98.2	98.2	97.3
14	Derris resins, 3 per cent in petrolatum (ointment)	26	117	0	5	84	0	1	2	25	96.7	97.4	76.1
15	Dipyridyl sulphate, 28 per cent, equal parts with water	22	113	0	7	22	0	1	66	17	30.2	40.7	25.7
16	Dipyridyl sulphate, 8 per cent, in dust	20	141	0	0	4	0	3	108	26	3.5	21.3	2.8
17	Kaolin, powdered	36	128	0	0	0	0	17	83	28	0	21.9	0
18	Nicotine (free), 1 per cent in hydrated lime	7	87	3	27	22	0	32	3	0	59.8	59.8	59.8
19	Nicotine (free), 2 per cent in hydrated lime	55	402	6	76	270	1	38	11	0	87.6	87.6	87.6
20	Nicotine (free), 3 per cent in hydrated lime	20	273	6	75	127	0	55	10	0	76.2	76.2	76.2
21	Nicotine (free), 3 per cent in tripoli earth	15	118	0	20	83	0	12	3	0	87.3	87.3	87.3
22	Nicotine sulphate, 3 per cent in kaolin	92	275	1	17	198	0	2	21	36	90.4	91.6	78.5
23	Nicotine sulphate, 3 per cent in cream silica earth	11	117	1	9	85	0	18	4	0	81.2	81.2	81.2

24 Paradichlorobenzene, 1 part, petrolatum, 5 parts (ointment)	46	211	25	29	27	4	54	72	0	38.4	38.4	38.4
25 Pyrethrum extract, 0.155 per cent oleo resin, plus soap and water (proprietary)	9	106	0	21	17	0	31	37	0	35.8	35.8	35.8
26 Pyrethrum extract, 0.166 per cent oleo resin, plus soap and water (proprietary)	11	118	0	16	4	0	33	65	0	16.9	16.9	16.9
27 Sulphur, so-called colloidal, recovered in manufacture of artificial gas	13	110	2	14	10	1	30	53	0	23.6	23.6	23.6
28 Tobacco powder, natural, 1 per cent nicotine, 80-mesh	30	211	7	31	96	1	40	33	3	63.8	64.9	63.
29 Tobacco powder, alkalin, 2.8 per cent nicotine, 80-mesh	14	132	3	26	74	1	21	7	0	78.0	78.0	78.0
30 Tobacco powder, natural, 3.04 per cent nicotine, 200-mesh	31	138	0	9	56	0	76	47	0	47.1	47.1	47.1
31 Tobacco powder, natural, 3.16 per cent nicotine, reground	34	232	1	30	192	0	4	2	3	97.4	97.4	96.1
32 Tobacco powder, natural, 3.16 per cent nicotine, not reground	9	109	4	24	39	0	37	5	0	61.5	61.5	61.5
33 Tobacco powder, natural, 5 per cent nicotine, 80-mesh	26	143	8	54	70	0	2	9	0	92.3	92.3	92.3
34 Tobacco powder, alkalin, 4.48 per cent nicotine, 80-mesh	45	128	0	5	92	0	4	13	14	85.1	86.7	75.8
35 Tobacco powder, natural, 8 per cent nicotine, 80-mesh	32	123	0	3	85	0	8	16	11	78.6	80.5	71.5
36 Tobacco powder, with free nicotine added, 3.19 per cent nicotine, reground	7	78	1	20	45	0	11	1	0	84.6	84.6	84.6
37 Tobacco powder, with free nicotine added, 3.18 per cent nicotine, not reground	11	98	1	32	43	0	19	3	0	77.6	77.6	77.6
38 Tobacco powder, with nicotine sulphate added, 3.06 per cent nicotine, reground	3	83	3	24	52	0	2	2	0	95.2	95.2	95.2
39 Tobacco powder, with nicotine sulphate added, 3.01 per cent nicotine, not reground	9	107	3	24	40	1	22	16	1	63.2	63.6	62.6
40 Tobacco, coarse ground, plus bentonite, 4 per cent nicotine (proprietary)	45	122	0	2	77	0	5	29	9	69.9	72.1	64.8
41 Tobacco ointment (1 part powder, natural, 1 per cent nicotine to 4 parts petrolatum)	8	105	1	28	39	0	32	5	0	64.8	64.8	64.8

grubs would complete development and leave the host. In the table the percentage of kill is computed on three different bases. The figures in the last column, "Per cent dead based on all grubs treated, if all grubs not found are considered as alive," give the lowest kill which could have occurred in these tests.

The greater efficacy of derris powders with the higher rotenone content clearly shows the insecticidal value of that material. The figures for the three grades of derris powder (powdered derris root) may be somewhat confusing. The smaller percentages of kill obtained with the powders containing the higher percentages of retenone may be explained by the physical condition of these powders. They were in shredded condition, which precluded the possibility of working them into the holes of the grubs satisfactorily. The results secured with derris powder from which the rotenone had been exhaustively extracted with ether would seem to show either that a very small quantity of rotenone remained, although enough to kill some of the larvae (27.5 per cent), or, what is more likely, that other derris compounds not extracted by ether have some toxicity to cattle grubs. The tests with powders consisting of kaolin containing 1, 2, or more per cent rotenone indicate that the 1 per cent strength is insufficient to give satisfactory results, but that the other two strengths gave almost a complete kill under the conditions described. "Cube" root should be considered with derris compounds, as it has recently been shown by Clark[3] to contain rotenone. In fact, in the samples examined by the Bureau of Chemistry the rotenone content ran from 5 to 10 per cent, uniformly higher than that in derris.

The control effected with free nicotine and nicotine sulphate, 2 to 3 per cent in a carrier, was fairly satisfactory throughout. Apparently there is little difference between the effectiveness of free nicotine and that of nicotine sulphate, when these are used in hydrated lime, tripoli earth, kaolin, or cream silica. There are practical objections, however, to the utilization of lime as a carrier, as is pointed out later in this paper. Tripoli earth is more satisfactory as a carrier than kaolin, which has a tendency to form small pellets and does not penetrate the hair so well. The results obtained in the tests of tobacco powders made from natural tobacco were somewhat erratic. The tests with the tobacco powder containing 3.1 per cent nicotine and with the same material which was reground (Items 31 and 32) would seem to show that the fineness, in this particular case at least, was an important factor, the reground powder giving a kill of 96.1 per cent as against 61.4 per cent with the

[3]Clark, E. P. The occurrence of rotenone in the Peruvian fish poison "Cube." Science (N. S.), Vol. 70. p. 478, Nov. 15, 1929.

other. Paradichlorobenzene in petrolatum (Item 24), recommended and rather extensively used in cattle-grub control work in France, is shown by the writers' tests to have little value, the kill being only 38.4 per cent. More finely pulverized crystals of paradichlorobenzene might give better results, as it was found difficult to pulverize them and to mix them thoroughly in the ointment.

TESTS OF INSECTICIDES APPLIED WITHOUT EXAMINING GRUBS BEFORE TREATMENT. In another series of tests the grubs were undisturbed, being left in their natural condition and undoubtedly more protected from the action of the insecticide than in the experiments reported in Table 1. The insecticides were applied with a shaker can, and the material was lightly rubbed into the hair, simulating the type of application which the average farmer would make. The quantity of material used varied greatly in the different tests, partly because several different men made the applications, a factor undoubtedly responsible to some extent for the great variation in the results indicated in Table 2.

Although the quantity of insecticide used was not determined in all tests, it is clear from the records kept that an insufficient quantity was employed to get the best results. For instance, in the test of nicotine sulphate, 3 per cent in tripoli earth, against *H. lineatum* (Item 6), the material was applied at the rate of 0.71 ounce per animal, or 7.3 ounces per 100 grubs. The much lower kill secured with natural tobacco powder, 3.17 per cent nicotine (Item 8) would be explained by the fact that only 0.19 ounce was used per animal, or 2.1 ounces per 100 grubs.

TESTS OF PERIODIC APPLICATIONS OF INSECTICIDES. In the tests of periodic treatments, as reported in Table 3, the grubs were not disturbed nor were the holes cleaned out. On the sixth and twelfth days after applying each treatment, the grubs were examined with as little disturbance as possible to determine whether they were dead or alive. Thus in the tests with 15-day intervals between treatments the second examination preceded the subsequent applications by three days. This allowed the living grubs to resume normal conditions by the time the following applications were made.

These tests were carried out in the vicinity of Dallas, Texas, beginning about December 1, when some of the grubs were mature, although young ones were still coming up. From two to four applications of the dusts were made during the period of test, the animals being practically free of grubs after that number of treatments had been given. Only those cattle which were infested were treated, and the applications were confined largely to the grubs; that is, the entire back of an animal was not dusted. A comparatively small percentage of the grubs was

TABLE 2. TESTS OF INSECTICIDES AGAINST HYPODERMA SPP. IN THE BACKS OF CATTLE; INSTAR OF GRUBS NOT DETERMINED BEFORE TREATMENT

Item No.	Material and strength used	Number of cattle treated	Number of grubs treated	Number of grubs dead Instar 3	4	5	Number of grubs alive Instar 3	4	5	Number dead but stage not determined	Number of grubs not found	Per cent dead, based on dead and alive only (excluding grubs not found)	Per cent dead based on all grubs treated: If all grubs not found are considered as dead	If all grubs not found are considered as alive
Hypoderma bovis														
1	Derris root, powdered, 0.5 per cent rotenone	25	102	0	0	81	0	0	4	7	10	95.7	96.1	86.3
2	Derris extract, 2.4 per cent crude rotenone in kaolin	46	197	0	0	38	0	0	61	63	35	62.3	69.0	51.3
3	Nicotine(free), 3 per cent in hydrated lime	37	101	0	0	64	0	0	20	1	16	76.5	80.2	64.4
4	Sulphur, so-called colloidal, recovered in manufacture of artificial gas	15	57	0	0	6	0	0	32	8	11	70.0	43.9	24.6
5	Tobacco powder, natural, 4 per cent nicotine, 200-mesh	38	125	0	6	31	0	0	53	8	27	45.9	57.6	36.0
6	Tobacco powder, natural, 4 per cent nicotine, 80-mesh	26	90	0	0	29	0	1	37	8	15	49.3	57.8	41.1
7	Tobacco powder, alkalin, 4 per cent nicotine, 80-mesh	49	177	0	0	56	0	1	51	35	34	63.6	70.6	51.4
8	Tobacco powder, coarse, natural, 4 per cent nicotine plus bentonite(proprietary)	40	94	0	0	52	0	3	24	0	15	65.8	71.3	55.3
9	Tobacco powder, natural, 6 per cent nicotine, 200-mesh	29	104	0	3	21	0	2	49	6	23	55.6	51.0	28.8
10	Tobacco powder, natural, 8 per cent nicotine, 80-mesh	21	101	0	1	62	0	0	11	3	24	84.6	89.1	65.3
11	Tobacco powder, alkalin, 8 per cent nicotine, 80-mesh	34	108	0	6	57	0	1	16	12	16	81.5	84.3	69.4

Hypoderma lineatum													
1 Derris root, powdered, 1.35 per cent rotenone	49	405	0	30	50	2	121	93	87	22	43.6	46.7	41.2
2 Derris root, powdered, 2.3 per cent rotenone	10	92	0	5	23	0	6	14	42	2	77.8	78.3	76.1
3 Nicotine (free), 3 per cent in tripoli earth	16	222	1	14	130	0	28	11	21	17	81.0	82.4	74.8
4 Nicotine (free), 3 per cent in cream silica earth	22	140	0	14	93	0	18	6	5	4	82.4	82.9	80.0
5 Nicotine (free),3 per cent in hydrated lime	22	210	2	19	94	0	30	13	29	23	77.0	79.5	68.6
6 Nicotine sulphate,3 per cent in tripoli earth	18	176	0	4	132	0	10	17	4	9	83.8	84.7	79.5
7 Pyrethrum powder, best grade, over 80 per cent passing through 170-mesh sieve	26	289	0	6	24	0	14	135	63	47	38.4	48.4	32.2
8 Tobacco powder, natural, 3.17 per cent nicotine	24	215	1	30	35	0	89	13	47	0	52.5	52.6	52.6
9 Tobacco powder, 6.06 per cent nicotine, 200-mesh	24	163	1	33	26	0	47	11	45	0	64.4	64.4	64.4

alive and still present when the second application was made, and practically none received the third treatment.

The percentage killed, as indicated in the last column, is the minimum, as some few of the grubs recorded as gone were probably killed, although all of those so recorded were considered as living in figuring the percentages. It is noteworthy that the kill secured with derris when applied at 15-day intervals (Item 1) and with nicotine dust, 3 per cent in lime (Item 6), is almost complete. The derris applications at 30-day intervals did not give as good results as would be expected from ground root with a rotenone content of 1.35 per cent. This may be explained by the physical condition of this powder. The same material was used as in the tests recorded in Table 1 (Items 4 and 5), in which case a rather low efficacy was noted as compared with the derris powder of proper physical condition and containing .5 per cent rotenone (Item 3).

TABLE 3. TESTS OF PERIODIC APPLICATIONS OF INSECTICIDES AGAINST *Hypoderma lineatum* IN BACKS OF CATTLE

Item No.	Material and strength used	Number days between treatments	Number of cows	Number of grubs treated	Number of grubs dead	Number of grubs gone	Per cent of grubs dead (based on number treated)
1	Derris root, powdered, 1.35 per cent rotenone.	15	38	195	192	3	98.46
2	Derris root, powdered, 1.35 per cent rotenone.	30	28	344	292	52	84.88
3	Lime, hydrated.....	15	5	60	56	4	93.33
4	Nicotine (free), 1 per cent in lime.....	30	37	477	432	45	90.57
5	Nicotine (free), 3 per cent in lime.....	30	30	155	147	8	94.84
6	Nicotine (free), 3 per cent in lime.....	15	38	263	262	1	99.62
7	Tobacco powder, natural 1 per cent nicotine....	15	35	341	322	19	94.43
8	Tobacco powder, natural 1 per cent nicotine....	30	36	242	187	55	77.27
9	Tobacco powder, natural 1.29 per cent nicotine..	15	61	295	267	28	90.51
10	Tobacco powder, natural 4 per cent nicotine 200-mesh.....	30	40	220	199	21	90.45
11	Tobacco powder, natural 4 per cent nicotine 200-mesh.....	15	34	170	159	11	93.53
12	Tobacco powder, natural 8 per cent nicotine 200-mesh.....	15	23	122	115	7	94.26

Attention is called to the fact that where the same materials were used at 15-day and at 30-day intervals, the shorter interval gave an

increase in the percentage of kill, ranging from 3.08 per cent in the case of tobacco powder containing 4 per cent nicotine (Items 10 and 11)to 17.16 per cent in that of tobacco powder with a nicotine content of 1 per cent (Items 7 and 8). The high degree of control effected by the use of hydrated lime (Item 3) is surprising, although the number of grubs treated was too small to give reliable results. Lime used alone, or even as a carrier, is objectionable because of its irritation to the throat of the operator and the somewhat drying and caustic effect it has on the skin of the cattle.

It is desirable to kill the grubs while young so that their adverse effect on the host may be terminated as soon as possible and their bodies may be more promptly disposed of by the host. Unfortunately, the killing power of powders is somewhat lower in the case of the younger stages than in that of the older ones, apparently because of the difficulty of getting the material through the small apertures and into the cysts. This fact and the tendency for farmers to miss some of the grubs when applying treatments make it advisable to give the treatments more frequently than would appear necessary on the basis of the life history of the insect. Probably the 15-day period would be better than the 30-day interval. The treatments should begin when the earliest grubs reach the fifth instar. This date would vary greatly in different sections and even in different seasons. The data on the seasonal history of cattle grubs as given in Department Bulletin 1369, pages 74–79, should serve as a general guide to those contemplating the initiation of control operations.

Methods of Applying Insecticides and their Effect on Cattle. It will be noted that special attention has been devoted to insecticides applied in dust form. Although certain washes and ointments have given excellent results, the authors feel that the application of dusts is more simple, especially in the case of cattle in pens or chutes. Furthermore, the wetting of the backs of the cattle is objectionable, particularly as the early applications must be made in winter.

Some owners of dairy herds favor the use of ointments, and this type of insecticide may be found to have a place, especially in the treatment of dairy herds. When ointments are used, some of the dead grubs are expelled from the cysts. This does not occur with insecticides applied as dusts or washes.

Thoroughness of application is of the utmost importance, regardless of the method employed. The material must actually enter the small holes in the skin to kill the grubs; hence it is necessary not only to apply it over each cyst but to work it well into the hair to insure getting some

into each hole. To make ointments effective they must be pressed into each hole, with the finger or otherwise.

The quantity of insecticide used is also of importance. If the material is carefully worked into each grub hole, less is required to get the same result than when a general and less thorough application is made. When the infestation is heavy, a general application is necessary. This is advisable also when farmers are doing the work, especially when the hair of the animals is long and thick. For such treatments two or three ounces per head is required. There may be some danger of toxosis to cattle from the general and heavy application of dusts containing 2 or 3 per cent of free nicotine. Although no injury was observed in these tests, it is known that the susceptibility of individual cattle to nicotine poisoning varies to a marked degree, and certain climatic conditions may also render the material more easily absorbed in quantity. As nicotine sulphate appears to have about the same killing power as free nicotine, the use of the former is advocated on account of its lower toxicity to the host. As a precaution, not more than 3 ounces of 2 per cent or 2 ounces of 3 per cent nicotine dust should be used on each animal. Natural tobacco powder is probably less toxic to the cattle than the dusts containing either free nicotine or nicotine sulphate, and would therefore be preferable from that point of view. If a tobacco powder of uniform physical condition and carrying about 2 per cent of nicotine could be made generally available at a comparatively low cost it would probably be a very satisfactory and practical insecticide for this purpose. No toxic effects on the cattle are to be expected from derris products, and they seem to have no deleterious influence on the skin. Some believe that it is not good practice to leave the dead grubs in the cysts. It should be pointed out, however, that in the rather extensive use of insecticides listed in this paper no injurious effects on the host have resulted from leaving the dead larvae in the cysts, except that occasionally the presence of the mature grubs may have retarded the healing of the holes in the skin.

The writers' experiments indicate that the condition of the skin, the length of the hair, and perhaps other host factors, as well as climatic conditions, may influence the results obtained from insecticidal treatments. A heavy winter coat of hair holds the material over the grubs and appears to favor their destruction, provided the insecticide is brought in close contact with the skin. On the other hand, such a condition of the hair often interferes materially with the application, and greater care is required to make it properly. The effect of insecticides on larvae which cut holes through the skin after the application has

been made has not been fully determined, but with some of the materials, at least, young grubs which cut holes through the skin several days after the insecticide has been applied are killed in a short time.

The authors believe the use of insecticides should be employed only where a concerted effort is being made to bring about a high degree of control. In such work, community action is desirable so that a very sharp reduction in the number of grubs will be brought about as a result of the first year's effort.

NEONICOTINE AND CERTAIN OTHER DERIVATIVES OF THE DIPYRIDYLS AS INSECTICIDES

By C. R. SMITH, *Bureau of Chemistry and Soils*, and C. H. RICHARDSON and H. H. SHEPARD, *Bureau of Entomology, United States Department of Agriculture*.[1]

ABSTRACT

Twenty-five dipyridyl derivatives and related compounds not previously reported have been prepared and tested as contact insecticides.

Neonicotine was the most toxic compound, comparing favorably in this respect with nicotine to which it is chemically similar.

In a previous publication (*1*)[2] the toxicity of "dipyridyl oil" prepared by the action of sodium on pyridine under conditions described by one of us (*2*) was compared with the dipyridyls isolated from the oil (alpha alpha, beta beta, beta gamma, and gamma gamma derivatives) and also with alpha beta dipyridyl prepared from a different source. The relatively high toxicity of the "dipyridyl oil" pointed to the presence of some other compound, probably a dipyridyl derivative, possessing high toxicity.

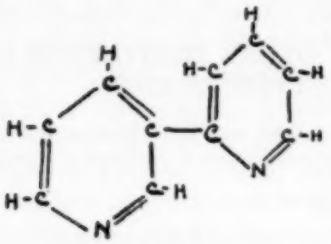
While the search for a method of separating the toxic compound was being made, the corresponding dipiperidyls (*3*) and certain of the pyridyl piperidines were prepared and tested with the idea that it might be one of these. The toxic compound, however, was finally prepared in the pure state and identified as beta pyridyl alpha piperidine. It was called neonicotine because its empirical formula is the same as that of nicotine and its toxicity is of the same order. The comparison, however, goes farther than this, as their chemical structure is very similar. It may be stated that no other possible pyridyl piperidine can compare

[1]The chemical work in connection with this subject is by Mr. Smith; the toxicity tests are by Dr. Richardson and Mr. Shepard. The authors are indebted to Mr. R. C. Burdette, who made some of the earlier tests.

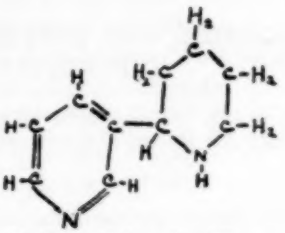
[2]Reference is made by number (italic) to "Literature cited," p. 867.

so closely to nicotine in structure as does neonicotine. Its toxicity is decidedly greater than that of any other dipyridyl derivative we have tested.

The detailed description of the chemical methods involved in the separation and identification of neonicotine from "dipyridyl oil" and the preparation of certain pyridyl piperidines will not be given here but will be published later by one of us. The dipyridyls, pyridyl piperidines, and the dipiperidyls are represented by the following types:

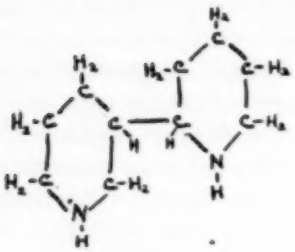


I $\alpha\beta$ Dipyridyl

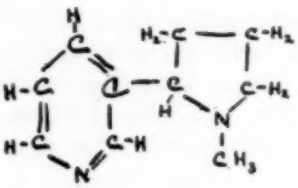


II β Pyridyl α piperidine (Neonicotine)

while nicotine is represented thus (iv):



III $\alpha\beta$ Dipiperidyl



IV Nicotine (β-Pyridyl-α-N-methylpyrrolidine)

Neonicotine boils at 280–281° C. It forms a picrate crystallizing from water in prismatic needles which melt at 213° (cor.). On reduction with hydrogen in the presence of platinum black alpha beta dipiperidyl is produced. Neonicotine can be readily methylated by methyl iodide or potassium methyl sulphate. The ethyl and propyl derivatives have also been prepared and other alkyl derivatives are in the course of preparation. Neonicotine is soluble in water in all proportions. It is very much less volatile with steam than is nicotine.

When alpha beta dipyridyl is reduced with tin and hydrochloric acid the beta ring is reduced, thereby forming not neonicotine but isoneonico-

tine which has very much less toxicity than the former. A study of methods for the reduction of the alpha ring to produce neonicotine is in progress.

The toxicity of each compound was determined by a method previously described (*4*), *Aphis rumicis* L. being the test insect. The solutions or emulsions were sprayed on dwarf nasturtium plants (*Tropaeolum majus*) well infested with the aphids. The per cent of aphids killed and the condition of the plants were determined after about 24 hours. In the earlier tests 0.3 per cent sodium fish-oil soap was used as a spreader. In the previous paper just cited (*4*) it was stated that this spreader showed little killing at the concentration used. Probably owing to unavoidable differences in susceptibility of the aphids and to slight changes in the application of the method of determining toxicity after a period of years, 0.3 per cent sodium fish-oil soap in blank experiments made during the time of these studies has been found to kill about 45 per cent of the aphids. In view of the toxicity of this low concentration of soap, experiments were also made in some cases with 1 per cent saponin which kills only about 14 per cent of the aphids. In a recent paper (*5, p. 1008*) soap and saponin have been compared with respect to toxicity.

The criterion of tolerance of the plant to a compound was the same as that described in the papers just cited (*4, 5*). The figures for tolerance are based on observations upon tests with both spreaders. They may be considered, therefore, as of general significance only.

The following table presents the results of these experiments and includes for comparison previously published data on nicotine and the dipyridyls. The mortality in each case is given without attempting to make allowance for the toxicity of the spreading agent.

These studies have involved compounds in three series: (1) the dipyridyls, of which there are 6 isomers in which both pyridine rings of each compound are unsaturated with hydrogen; (2) the dipiperidyls, consisting of 6 isomers which correspond with the previous group and in each of which both rings are completely saturated; and (3) the pyridyl piperidines, of which there are 9 each with one ring unsaturated and the other saturated. Of the dipyridyls tested $\alpha\beta$-dipyridyl is the most toxic. Of the four dipiperidyls that are tested in the form of bases $\beta\gamma$-dipiperidyl shows the greatest toxicity. $\alpha\beta$-dipiperidyl as a base, however, might be more toxic, in which case the order of toxicity in each of the two series would be nearly the same for the various isomeric forms. The dipiperidyls are for the most part more toxic than the corresponding dipyridyls.

TABLE

Compound	Spreader, 0.3 per cent soap Concentration, g. per 100 c.c.	Number of aphids	Per cent killed	Spreader, 1 per cent saponin Concentration, g. per 100 c.c.	Number of aphids	Per cent killed	Tolerance of plant g. per 100 c.c.
Nicotine.....	0.01	287	99	0.1	868	99	>0.05
	.001	709	67	.01	1048	39	
αα—Dipyridyl.....	.5	925	93	—	—	—	< .5
	.1	813	60	—	—	—	
αβ—Dipyridyl.....	.5	350	100	.5	485	59	< .5
	.1	298	70	.1	548	38	
ββ—Dipyridyl.....	1.0	959	94	—	—	—	.1
βγ—Dipyridyl.....	.75	1046	97	—	—	—	.1
	.3	818	59	—	—	—	
γγ—Dipyridyl.....	.73	125	84	—	—	—	< .25
αα—Pyridylpiperidine	.5	494	97	—	—	—	—
	.1	364	74	—	—	—	
αβ—Pyridylpiperidine	.5	956	95	—	—	—	< .1
	.05	1148	87	—	—	—	
βα—Pyridylpiperidine (Neonicotine)	.05	860	100	.1	689	99	> .5
	.005	377	95	.02	849	56	
ββ—Pyridylpiperidine. (Nicotidine)	.5	248	96	.5	345	94	> .5
	.05	320	48	.1	304	44	
γγ—Pyridylpiperidine (Isonicotine)	2.1	300	99	—	—	—	< .29
	1.05	437	87	—	—	—	
αα—Dipiperidyl.....	.66	239	97	.5	245	60	.5
	.1	185	54	.1	251	32	
αβ—Dipiperidyl dihydrochloride....	.1	482	45	.5	506	12	> .5
ββ—Dipiperidyl.....	.35	398	91	—	—	—	< .1
	.1	433	60	—	—	—	
βγ—Dipiperidyl.....	.1	254	99	—	—	—	> .1
	.01	366	83	—	—	—	
γγ—Dipiperidyl.....	2.1	797	69	—	—	—	1.0
ββ—Dipyridyldicarboxylic acid...	Sat. soln. (less than 1.0)	783	39	—	—	—	>Sat. soln.
αβ—Dipyridylmonocarboxylic acid hydrochloride.	.2	285	89	.2	406	34	> .2
αβ—Dipyridyldimethyliodide.....	—	—	—	.5	473	34	>0.5

TABLE—*Continued*

$\gamma\gamma$—Dipyridyldimethyliodide.....	——	——	—	.5	423	39	> .5
$\gamma\gamma$—Dipyridyldibenzylbromide....	——	——	—	.5	300*	<10*	> .5
Mono-N-methyl-$\alpha\beta$—pyridylpiperidine.....	——	——	—	.5	353	84	.5
Methylneonicotine	——	——	—	.1	1024	90	> .5
	——	——	—	.02	1166	43	
Methyl nicotinate	1.0	466	49	—	—	—	<3.0
Ethyl nicotinate	1.0	391	32	—	—	—	>1.0
α—Aminopyridine..	2.0	484	95	—	—	—	2.0
β—Aminopyridine..	1.1	481	84	—	—	—	——
Tetrahydro-α-aminopyridine dihydrochloride	1.2	218	94	—	—	—	.6
β—Bromopyridine..	5.0	490	88	—	—	—	<5.0
Piperidine oxide..	1.2	775	73	—	—	—	.6
Phenanthroline (Reduced)	——	——	—	.41	297	34	> .41

*Estimated

The pyridyl piperidines are particularly interesting to compare with nicotine. The latter compound differs from them in chemical structure in that it contains a saturated five-membered ring (pyrrolidine) in place of a saturated six-membered ring (piperidine). The most toxic of the pyridyl piperidines is the $\beta\alpha$ isomer, which has been called neonicotine, corresponding structurally with nicotine in which the unsaturated and saturated rings are also attached in the $\beta\alpha$ position. Most remarkable is the fact that neonicotine ($\beta\alpha$-pyridyl piperidine) has practically the same toxicity as nicotine. It is of much interest to note further that the $\alpha\beta$ isomer, although being very much less toxic than neonicotine, is more toxic than the other compounds of the series that have been investigated. In each series, then, the compounds with the $\alpha\beta$ and $\beta\alpha$ groupings lead in toxicity over the compounds with the rings located in other positions.

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ROTENONE AS A CONTACT INSECTICIDE

By W. M. DAVIDSON, *Associate Entomologist, Insecticide Control, Food and Drug Administration, Silver Spring, Maryland*

ABSTRACT

Several different types of insects were tested with rotenone in an aqueous suspension and in dust form, the carrier being diatomaceous earth intimately mixed with precipitated rotenone. The aqueous suspensions were highly toxic to aphids, thrips, white fly larvae, leaf hoppers, larvae of beetles, tent caterpillars and culicine mosquitoes. Adult beetles required a much higher concentration. Poor results were obtained against squash bugs, red spiders and mealy bugs; this might have been remedied by the addition of a penetrating and sticking agent, as there is good evidence that the active ingredients of derris are toxic to these insects under optimum conditions of application.

The dusts were effective against chicken lice, roaches and cabbage worms, but results against soft bodied sucking insects were not so good.

For many years it has been known that the extracts from the roots of some of the tropical leguminous plants formerly embraced in the genus Derris, but now classed as the genus Deguelia, have high insecticidal value. The literature on this subject is extensive and a recent bibliography[1] lists 334 papers. Of these, 56 report actual tests with Derris extracts or commercial derris products. There are 36 papers giving results of tests against soft-bodied insects, including aphids, thrips, leaf-hoppers, caterpillars, and insect eggs. Nineteen papers report tests against insect pests of animals (warbles, lice, fleas, flies). Six papers report tests against mosquito larvae and four deal with soil insects (root maggots, leather jackets). A few insects of other types are mentioned, but the great majority of the work concerned the types listed above.

These published data are consistent in the main but there are a few inconsistencies. Recent chemical research into the constituents of derris has brought to light facts that may explain these inconsistencies. It has been ascertained that there are four major toxic constituents which vary widely in actual percentage and also in the proportions one to another,—no two samples of roots showing exactly the same proportions and amounts. Of these four toxic constituents, rotenone is the most important. Samples of derris root have been found to contain as much as 6 per cent by weight of this compound, but a few samples have contained none. Rotenone also occurs in "cube" roots (*Lonchocarpus nicou*) and in timbo, haiari, and other members of the genus Lonchocarpus.

[1] A Bibliography of Derris (Deguelia) species used as Insecticides (1747–1929). R. C. Roark, Insecticide Division, Bureau of Chemistry and Soils.

This paper reports tests to determine the value of rotenone as a contact insecticide against many species of insects. A later paper will contain data on the other three constituents.

EXPERIMENTAL. In the experimental work reported in this paper the rotenone used was of the highest purity, recrystallized from alcohol, and melted sharply at 163° C. It was obtained from Dr. F. B. LaForge of the Insecticide Division, Bureau of Chemistry and Soils. Tests were made with rotenone applied in two ways: (1) as a spray; (2) as a dust.

Rotenone is quite insoluble in water. Since it is easily affected by aqueous alkalies, it was thought best not to attempt to emulsify it in water with the aid of soap. Consequently the rotenone was dispersed in water, in all the tests reported in this paper, by dissolving it in acetone at the rate of about 4 grams per 100 cc. of acetone and adding this solution to water to form the dilution desired. Jones and Smith (J. Am. Chem. Soc. 52:2554, 1930) show that rotenone has a higher solubility in acetone than in any of the other water-miscible solvents which they tried, 100 cc. of acetone at 20° C., dissolving 6.6 grams of rotenone. The suspension of rotenone obtained by adding the acetone-rotenone solution to water was applied immediately to the insects. Furthermore, the concentrated solution of rotenone in acetone was freshly prepared before all tests. (In work to be reported by the author and Jones, it has been found that rotenone decomposes rather rapidly on standing in a number of organic solvents.) The water used in all the spraying tests reported in this paper was tested by C. G. Donovan, Assistant Chemist, Food and Drug Administration and found to contain a total of 3 grains solids per gallon. The pH was 7.1. The results of the spraying tests are shown in Table 1.

DISCUSSION OF TABLE 1. The physical nature of the diluted sprays, lacking a sticking or penetrating constituent, tended to cause them to run off such glabrous foliage as that of cabbage and nasturtium. Under these conditions of negligible adhesiveness and penetration, the great toxicity of rotenone stands out in high relief.

Three common greenhouse-inhabiting aphids were controlled at concentrations of 1:100,000 and 1:200,000. Field tests on three species of fruit tree aphids indicated that control was obtained at 1:40,000 and 1:60,000. Eggs of the pine woolly chermes (*Adelges*) were not killed at 1:20,000; untabulated tests with solutions of rotenone in pyridin dispersed in water showed that the nymphs are controllable at this concentration.

TABLE 1. CONTACT INSECTICIDAL ACTION OF ROTENONE ON VARIOUS INSECTS WHEN APPLIED AS A SUSPENSION IN WATER

(a) *Tests in a Greenhouse*

Insect Species, stage, and host plant	Concentration Gram: cc	Net Mortality Per cent
APHIIDAE		
Aphis rumicis L. active, on nasturtium	1:100,000	99.5
	1:200,000	100.0
	1:300,000	97.0
Brevicorne brassicae Koch, active, on cabbage	1:100,000	100.0
	1:200,000	97.4
Myzus persicae, Sulz., active, on cabbage	1:100,000	98.2
	1:200,000	94.3
COCCIDAE		
Pseudococcus citri Risso, active, on coleus	1:250	25.0
ALEYRODIDAE		
Trialeyrodes vaporariovum	1:2,000	99.1
Westwood[1] ova, on bean, etc	1:20,000	82.0
	1:100,000	9.6
Trialeyrodes vaporariovum		
Westwood, larvae, on bean, etc	1:30,000	94.9
	1:60,000	88.8
	1:100,000	94.7
Trialeyrodes vaporariovum		
Westwood, pupae, on bean, etc	1:250	0.0
THYSANOPTERA		
Thrips tabaci Lind., adults and larvae, on bean, etc	1:20,000	94.2
	1:30,000	69.3
	1:100,000	0.0
BLATTIDAE		
Blattella germanica L., active, in a wire cage	[2]1:250	0.0
	1:2,000	10.0
	1:10,000	10.0
LASIOCAMPIDAE		
Malacosoma americana Harris	1:100,000	47.0
3rd stage larvae, on plum and apple		
Malacosoma americana Harris	1:30,000	100.0
1st and 2nd stage larvae, on plum and apple		
TETRANYCHIDAE		
Tetranychus telarius L., active, on bean	1:90	78.6
	1:1,000	64.5
	1:2,000	60.7
	1:20,000	18.5

(b) *Tests in the Field*

APHIIDAE		
Anuraphis roseus Baker, active, on apple	1:40,000	96.3
	1:60,000	90.2

[1]The mortality recorded pertained to the hatching larvae; eggs were not prevented from hatching, but the young larvae died. Larvae hatching from eggs deposited on the plant *after* spraying developed normally.

[2]Dipped 30 secs.

TABLE 1.—*Continued*

Aphis persicae-niger Smith, active, on peach	1:40,000	98.3
Aphis pomi De Geer, active, on apple	1:60,000	99.0
PHYLLOXERIDAE		
Adelges, ova, on pine	1:20,000	0.0
CICADELLIDAE		
Typhlocyba comes Say, nymphs, on grape	1:100,000	100.0
COREIDAE		
Anasa tristis De Geer	1:250	10.0
hibernating adults and nymphs, on squash	1:500	5.0
THYSANOPTERA		
Thrips sp., larvae, on *Plantago lanceolata*	1:10,000	100.0
	1:20,000	39.0
CHRYSOMELIDAE		
Diabrotica 12-punctata Oliv., adults, on potato	1:20,000	0.0
Doryphora 10-lineata Say., adults, on potato	1:2,000	60.0
	1:5,000	12.0
	1:10,000	0.0
Doryphora 10-lineata Say., ova, on potato	1:30,000	100.0
Doryphora 10-lineata Say., small larvae, on potato	1:30,000	95.0
Doryphora 10-lineata Say., large larvae, on potato	1:10,000	96.5
	1:30,000	92.9
COCCINELLIDAE		
Epilachna corrupta Muls., adults,[3] on bean	1:5,000	100.0
	1:10,000	85.0
	1:20,000	0.0
Epilachna corrupta Muls., small larvae, on bean	1:60,000	93.3
SCARABAEIDAE		
Popilia japonica Newman[4]		
adults, on smartweed (*Polygonum*)	1:1,000	100
foliage, in screen cages	1:5,000	97.3
	1:7,500	88.8
	1:10,000	85.8
	1:15,000	86.1
	1:20,000	60.9
CULICIDAE		
Culicine mosquito	1:1,150,000	98–99[5]
larvae in tubs	1:2,300,000	95[6]

[3]Overwintered beetles: others of the fall brood treated in October were much more resistant; less than 50 per cent. were killed at 1:500 and 1:250; all were killed at 1:125.

[4]These tests were made by L. J. Bottimer, Food & Drug Administration, Haddon Heights, N. J., in July 1930.

[5]These larvae were dead within 5 days. The eggs present hatched and the resultant larvae died within 2 days.

[6]Ninety-five per cent of the larvae were dead in 6 days but the remainder transformed into pupae. The eggs present hatched and 20% of the resultant larvae survived. Larvae and eggs in untreated tubs showed no abnormal mortality.

Mealy bugs (*Pseudococcus*) and red spiders (*Tetranychus*) were very resistant to the rotenone suspension.

Nymphs of the grape leaf-hopper were killed at 1:100,000.

A concentration of 1:20,000 was hardly sufficient to control the onion thrips under greenhouse conditions, and was of little value in the field against another species of thrips. A field test against adult *Frankliniella* infesting daisy flowers was made with a solution of rotenone in pyridin; a concentration of 1:16,000 killed 99 per cent and 1:20,000 killed 93.5 per cent. It would appear that effective concentration against thrips lies in the vicinity of 1:16,000 rotenone.

All stages of the larvae of the greenhouse white fly (*Trialeyrodes vaporariorum*) were controlled by a concentration of 1:30,000. The first stage larvae succumbed to a much greater dilution. The eggs were less easily killed; sprayed eggs hatched but most of the hatching larvae died without freeing themselves of the shell, and others freed themselves only to die later without growing. The pupae were very resistant.

Squash bugs (*Anasa tristis*), including the nymphs in the later stages, and the common roach (*Blatella germanica*) proved very resistant to the rotenone suspension. Small tent caterpillars were easily killed. Tests with the pyridin solution indicated that larvae in the penultimate instar of the imported cabbage butterfly (*Pontia rapae* L.) were killed at a concentration of rotenone 1:75,000. Similar tests against the earliest nymphal state of squash bugs resulted in 84 per cent mortality at a rotenone concentration of 1:5,000 and in a 61 per cent mortality at 1:10,000. This type of insect is not readily controlled by aqueous suspensions, requiring a carrier of penetrating ability in the spray.

Adult potato beetles (*Doryphora 10-lineata*) were highly resistant, the eggs and larvae susceptible. A concentration of 1:5,000 controlled Japanese beetles tested in cages of the type commonly used by the Japanese Beetle Laboratory, Bureau of Entomology.

No foliage injury, even in the case of such susceptible plants as peach, string bean and Japanese plum, resulted in any instance.

Two dusts containing respectively one per cent and two per cent rotenone were prepared by the Insecticide Division of the Bureau of Chemistry and Soils. The rotenone used was prepared by precipitation from a solution in acetone by the addition of water, in order to obtain it in a very finely divided form, and mixed intimately with diatomaceous earth. Results of these tests are shown in Table 2. In the tests against phytophagous insects, the infested plants were dry at the time of applying the dusts.

TABLE 2. CONTACT INSECTICIDAL ACTION OF ROTENONE ON VARIOUS INSECTS WHEN APPLIED AS A DUST DILUTED WITH DIATOMACEOUS EARTH

Species of insect, stage and host plant	Net Mortality 1% rotenone Per cent	2% rotenone Per cent
(a) *Tests in a Greenhouse*		
APHIIDAE		
Aphis rumicis L., active, on nasturtium	—	100.0
Myzus persicae Sulz., active, on cabbage	—	76.6
Aphis gossypii Glover, active, on celery	—	68.9
COCCIDAE		
Pseudococcus citri Risso, active, on coleus	—	0
THYSANOPTERA		
Thrips tabaci Lind., larvae, on bean	—	65.5
TETRANYCHIDAE		
Tetranychus telarius L., active, on bean	—	0
(b) *Tests in the Field*		
APHIIDAE		
Aphis pomi, active, on apple	77.2	—
Illinoia liriodendri Monell, active, on tulip tree	—	88.4
COREIDAE		
Anasa tristis, nymphs, on squash	<50.0	<50.0
PIERIDAE		
Pontia rapae L., large larvae, on cabbage	100	100.0
COCCINELLIDAE		
Epilachna corrupta Muls., half-grown larvae, on bean	100	—
(c) *Tests in a Cage*		
BLATTIDAE		
Blattella germanica L., active	99	100
(d) *Tests in a Coop*		
MALLOPHAGA		
Menopon pallidum Nitzch. and *M. stramineum* Nitzch., on chickens	100	100

The dusts were not very effective against sucking insects. The cabbage worms and bean beetle larvae died almost instantaneously and were evidently killed by contact. The roach tests were made in small frame cages 9½" x 7½" x 2¼" inside measurements. When the dust was applied directly on the insects all died within 24 hours. The rotenone was partially effective upon roaches placed in the dusted cages 21 hours after application to the cages, indicating that some of the roaches were poisoned by ingesting particles of rotenone. Examination of dusted fowls showed that all the body lice, and the shaft lice dusted with the two per cent dust, had dropped off within 48 hours. The one per cent dust did not entirely free the fowls of shaft lice within 2 days, but a

second examination, 3 days after the first, failed to show any living shaft lice. This test did not disclose whether the rotenone acted as a contact, a repellent, or as an internal poison.

SUMMARY. A series of preliminary tests against insects representative of different types, and amenable to control by contact insecticides, indicates that rotenone, a product extracted from the root of derris, has a high degree of toxicity. The results obtained from the use of suspensions and dusts tend to confirm those reported by other investigators for derris extract. In suspensions, rotenone proved valuable against such soft-bodied insects as aphids, thrips, leaf-hoppers, caterpillars, beetle larvae, and the immature stages of culicine mosquitoes. When freshly dispersed in water by dilution of an acetone solution, rotenone is effective against *Aphis rumicis* at a concentration about one-fifteenth of that at which nicotine is effective. Aqueous suspensions were not effective against red spiders, mealy bugs, and squash bugs. This inefficiency against squash bugs, red spiders and possibly mealy-bugs, appears due more to lack of penetrating power in the suspensions used than to absence of intrinsic toxicity, and would probably be remedied by incorporating rotenone in a penetrating carrier, such as an oil. Roaches, potato beetles and cucumber beetles resisted the suspension sprays.

Dusts containing one and two per cent rotenone were only moderately effective against soft-bodied sucking insects. They controlled cabbage worms, young Mexican bean beetle larvae, roaches, and both body and shaft lice on chickens; the roaches, perhaps, more through internal poison than contact action.

THE ECONOMICS OF PYRETHRUM[1]

By JOHN GLASSFORD, *Chief Chemist, McCormick & Co., Inc., Baltimore, Md.*

ABSTRACT

Japan now produces 6/7 of the world's pyrethrum flowers. The imports into the United States have increased from 3,000,000 lbs. in 1923 to 9,000,000 lbs. in 1929. Average consular invoice values decreased from 47c a lb. in 1923 to 18c a lb. in 1929. A 1% lubricating oil spray costs about 0.3c per gallon; a lead arsenate spray, 1.2c.; a lime sulphur spray, 1.75c.; a nicotine spray containing 0.04 per cent of alkaloid, 1.84c; and a pyrethrum spray, containing 0.04 per cent of oleoresin of pyrethrum and activated with soap, costs 2.2c per gallon.

The cost of waging warfare against his insect enemies is an item of growing importance to the farmer. Arsenic, sulphur, lime and oil,

[1]Presented before the Division of Agricultural and Food Chemistry at the Atlanta meeting of the American Chemical Society in 1930.

which for so many years have been his principal weapons of attack or defense, must now often be replaced by insecticides which are less poisonous to man, more effective or both. Among these newer insecticides are two of vegetable origin which have proved to be very valuable weapons and one which promises to be. These are nicotine, the pyrethrins, and rotenone. Of these only the pyrethrins and rotenone are strictly non-poisonous, but nicotine, being volatile does not leave a poisonous residue. The cost of these vegetable insecticides, however, is greater than that of the mineral poisons so long used and is sometimes prohibitive. This has been particularly true of the pyrethrins. Recent investigations, however, have shown that, used with the proper materials to spread, or, as it is sometimes said, "activate," a spray of remarkably increased toxicity is obtained and the cost of spraying correspondingly reduced.

Pyrethrum, containing the pyrethrins, has been known for many years, but it has, until recently, been used only against household pests, its cost being the principal obstacle to its field use. Pyrethrum is not now grown commercially in this country although it was formerly so grown in California and probably will be again. Twenty-five or thirty years ago, there were two pyrethrums on the market; the Persian and the Dalmatian. The Persian, which was red, was *Pyrethrum roseum;* the Dalmatian, which is yellow, is *Pyrethrum cinerariaefolium*. The Persian flowers have disappeared entirely from the market and the cultivation of the yellow variety has been taken up by the Japanese who now supply six-sevenths of the world's production. The imports of the United States have increased from about 3,000,000 pounds in 1923 to 9,000,000 pounds in 1929. The maximum world production was in 1928 when the total reached almost 19,500,000 pounds, of which Japan produced 17,750,000 and consumed 5,000,000. The United States uses 70 per cent of the world's production. Average consular invoice values decreased from 47 cents a pound in 1928 to 18 cents a pound in 1929.

Pyrethrum was first used as a field spray against the Cochylis and Eudemis infesting the grape vines of France. It was used in the form of an emulsion with 15 pounds of pyrethrum per hundred gallons. Such a spray in 1923 would have cost 7½ cents per gallon, and even with pyrethrum at present prices it would be prohibitive for most purposes. A 1 per cent lubricating oil spray costs about 0.3 cents per gallon. A lead arsenate, spray suitable for use against the Japanese Beetle in corn, costs 1.2 cents per gallon; a lime sulphur spray, 1.75 cents per gallon and a nicotine spray containing 0.04 per cent of the alkaloid costs 1.84 cent per gallon. A pyrethrum spray containing 0.04 per cent

of oleoresin and activated with soap, costs 2.2 cents per gallon which makes it the highest priced of any of the sprays in common use.

In spite of their high price, however, pyrethrum sprays are indispensable for some purposes, against the blunt nosed leaf hopper infesting cranberry bogs and transmitting the virus of the false blossom disease for instance. And against the celery leaf tier there is no substitute, only pyrethrum dust may be used. In other cases as that of the Mexican bean beetle, only pyrethrum sprays can be effectively used when the crop is approaching maturity and the magnesium arsenate effective in the earlier stages can no longer be used on account of its poisonous nature. No doubt, the efficiency and harmlessness of pyrethrum would lead to its very extensive use if the obstacle of its high cost could be in part overcome. A number of scientists are working to this end. Staudinger and Harder, the former of whom, with Ruzicka, first isolated the pyrethrins, are again pioneers in the development of a method for the chemical assay of pyrethrum preliminary to the development by selection and propagation of a strain of *Pyrethrum cinerariaefolium* of higher toxic value than that now grown. Gnadinger and Corl find that pyrethrum flowers which have fully opened, contain 18 to 61 per cent more pyrethrin than the closed flowers which for so many years have been thought to be superior. As the average weight of the open flowers is about double that of the closed, Gnadinger and Corl suggest trebling or quadrupling the weight of the toxic principles obtained per acre of pyrethrum cultivated by the simple expedient of allowing the flowers to reach maturity. Sievers of the Bureau of Plant Industry proposes the concentration of pyrethrum by threshing to separate the achenes which contain 90 per cent of the pyrethrin. This concentration will save both freight and cost of grinding which is now about 3 cents a pound, for the impalpable powder. A saving in the cost of extraction would also be effected.

The price of pyrethrum flowers at Kobe, Japan, according to a report of the Department of Commerce was 15¾ cents per pound on January 25th, last, with prospects that the price would be forced down to 14½ cents per pound, cost and freight to New York, for new crop flowers. While exact figures on cost of production are not available, it would seem that a price of at least 15 cents per pound is necessary to insure continued cultivation. If crops can be doubled by being allowed to mature more fully before harvesting, it is possible that cultivation will pay at 12 cents per pound and taking into consideration the increased activity of the larger crop, it may be possible that a finished pyrethrum spray may be reduced to one-half its present price per gallon, or about

1.5 cents which is comparable with the lead arsenate spray at 1.2 cent per gallon. Similarly with pyrethrum dusts, while the price of pure pyrethrum powder is prohibitive its extract carried on the surface of dust particles is increased in efficiency many fold and the cost of dusting correspondingly reduced. Used in this way the pyrethrins are efficient for some purposes at a dilution of 1 to 133,000.

The two rotenone-containing insecticides, Derris from the East Indies and Cube from South America, also promise to be useful vegetable insecticides. Derris contains 0.5 to 5.5 per cent of rotenone, and cube up to 7 per cent with an average of about 4 per cent. Rotenone is said to be on the average, about equal in toxicity to pyrethrin. Commercial prices on these insecticides are not yet stabilized, but if they can be obtained as cheaply as it is hoped, finished sprays may possibly be made for from ¾ to 1 cent per gallon.

The Bureau of Chemistry and Soils is endeavoring to synthesize rotenone. The successful accomplishment of this task may lead to still lower production cost and give the farmer one of the most powerful weapons that ever has been devised for use against the arch enemies of all mankind in what Dr. L. O. Howard has called the greatest war of all times.

THE RELATIVE VALUE AS CONTACT INSECTICIDES OF SOME CONSTITUENTS OF DERRIS*

By W. M. DAVIDSON, *Associate Entomologist, Insecticide Control, Food and Drug Administration, Silver Spring, Maryland*

ABSTRACT

Aqueous suspensions of the four principal constituents of Derris root, i.e., rotenone, deguelin, tephrosin and toxicarol, were sprayed upon aphids, thrips, white fly larvae and red spider mites living on potted plants in a greenhouse. Their relative contact insecticidal value was in the order given, with rotenone the most potent; with reference to *Aphis rumicis*, they stood in the approximate ratio of 400:40:10:1. Rotenone and deguelin are both more toxic than nicotine to *A. rumicis*.

Clark (Science 71:306, 1930; J. Am. Chem. Soc. 52:2461, 1930) has isolated and described three constituents of Derris root other than rotenone. These are deguelin,[1] pale green crystals, $C_{23}H_{22}O_6$, melting

*The data in this paper were presented in part in a paper entitled "Tests of the Insecticidal Value of Derris Constituents" read at the Insecticide Symposium of the Division of Agricultural and Food Chemistry of the 79th Meeting of the American Chemical Society, Atlanta, April 8, 1930.

[1]Deguelin is the name recently given by Clark to the $C_{23}H_{22}O_6$ compound described by him in the articles cited. Private communication from E. P. Clark, Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.

point 171°; tephrosin, colorless crystals, $C_{23}H_{22}O_7$, melting point 198°; and toxicarol, yellow crystals, $C_{23}H_{22}O_7$, melting point 219°.

Deguelin and toxicarol have been shown by Gersdorff[2] to be highly toxic to goldfish. For example, at a dilution of 1 part in 20,000,000 parts water at 27° C. goldfish weighing approximately 2 grams were killed by rotenone in 2½ hours, by deguelin in 3 hours, and by toxicarol in 5 hours. At this concentration, tephrosin did not kill goldfish in 24 hours but at higher concentrations it approaches the toxicity of toxicarol. Tattersfield, Gimingham and Morris (Ann. Appl. Biol. 12:61–76. 1925) have published the results of insecticidal tests with tephrosin but no work has been reported by entomologists with toxicarol or deguelin.

EXPERIMENTAL. The pure compounds, deguelin, tephrosin and toxicarol were obtained from E. P. Clark, of the Insecticide Division of the Bureau of Chemistry and Soils. The crystals of rotenone, deguelin and tephrosin were dissolved in acetone and those of toxicarol were dissolved in ethyl alcohol to which a few drops of 10 per cent sodium hydroxide solution had been added. When their solutions were added to water these compounds were precipitated out in the form of finely dispersed suspensions. These suspensions were immediately sprayed upon the insects. No soap, saponin, or other wetting or spreading agent, was added in any test. All tests were conducted in a greenhouse.

The results are shown in Table 1.

DISCUSSION. These comparative data, incomplete as they are, indicate nevertheless that, as a contact spray, rotenone is considerably the most toxic of the four compounds when prepared for application as indicated. Deguelin appears to hold a position intermediate in toxic value between rotenone on the one hand and tephrosin and toxicarol on the other. The relative toxicity of these compounds to Aphis rumicis is approximately as follows:

Rotenone	deguelin	tephrosin	toxicarol
400	40	10	1

Comparing these results with those reported by Richardson and Smith (U. S. D. A. Dept. Bul. 1160, 1923) for nicotine, it is shown that rotenone and deguelin are more toxic to *Aphis rumicis* than is nicotine.

The gradation in toxicity of these four substances forms a clue to the variations in insecticidal potency that have been observed in samples of Derris root. One would expect a sample low in rotenone and high in toxicarol to yield results inferior to those secured from a sample of

[2]Private communication from W. A. Gersdorff, Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.

TABLE 1. TESTS WITH FOUR CONSTITUENTS OF DERRIS ROOT AS CONTACT INSECTICIDES

Insect and Host Plant	Suspensions in Water Sprayed Concentration Gram. cc.	Net Mortality Rotenone Per cent	Deguelin Per cent	Tephrosin Per cent	Toxicarol Per cent
Aphis rumicis L. on nasturtium	1 : 500	—	—	—	94.5
	1 : 5,000	—	—	100.00	—
	1 : 10,000	—	100.0	—	0.0
	1 : 20,000	—	100.0	65.0	0.0
	1 : 30,000	—	99.0	—	—
	1 : 200,000	100.0	—	—	—
Brev. brassicae Koch on cabbage	1 : 500	—	—	—	0.0
	1 : 5,000	—	94.0	0.0	0.0
	1 : 10,000	—	95.1	—	—
	1 : 20,000	—	—	0.0	—
	1 : 30,000	—	66.4	—	—
	1 : 100,000	100.0	—	—	—
Trialeyrodes vaporariorum Westwood, larvae, on bean, etc.	1 : 500	—	—	—	25.0
	1 : 2,000	—	19.7	—	—
	1 : 5,000	—	25.0	0.0	5.0±
	1 : 20,000	—	34.0	14.0	5.0±
	1 : 30,000	94.9	23.0	—	—
Thrips tabaci Lind. on bean, etc.	1 : 250	—	—	—	12.0
	1 : 2,000	—	50.0+	—	—
	1 : 10,000	—	50.0+	—	0.0
	1 : 20,000	94.2	—	—	—
Tetranychus telarius L. on bean, etc.	1 : 2,000	60.7	10.0±	—	18.0
	1 : 5,000	—	10.0±	10.0±	12.0
	1 : 20,000	18.5	—	10.0±	10.0

reverse composition. From our present knowledge of the chemistry of derris root, and of the value of its constituents as contact insecticides, it would appear that the rotenone content is the most important criterion for measuring the value of any sample of root. Unless occurring in unusually high content, the three other constituents would not substantially affect the insecticidal quality of the extract from such a sample.

ROCKY MOUNTAIN CONFERENCE OF ENTOMOLOGISTS

The seventh annual Rocky Mountain Conference of Entomologists was held at Pingree Park, Colorado, August 18 to 23 inclusive. Unprecedented rains in some localities just before the Conference discouraged some from making the trip by automobile, but the weather cleared and was ideal during the entire week.

A total of 52 were in attendance. The following are those that were directly interested in Entomology:

C. L. Marlatt	Washington, D. C.
C. P. Gillette	Fort Collins, Colorado
Bernard Liston	Wichita, Kansas
A. W. Lindquist	Manhattan, Kansas
Carl A. Bjurman	Fort Collins, Colorado
John C. Hamlin	Salt Lake City, Utah
W. A. Shands	Grand Junction, Colorado
Esther Travis	Fort Collins, Colorado
W. H. Larrimer	Washington, D. C.
C. J. Drake	Ames, Iowa
Miriam A. Palmer	Fort Collins, Colorado
Geo. I. Reeves	Salt Lake City, Utah
John L. Hoerner	Fort Collins, Colorado
Sam. C. McCampbell	Fort Collins, Colorado
Tom A. Brindley	Ames, Iowa
Rowan Potter	Wichita, Kansas
D. G. Rice	Grand Junction, Colorado
J. H. Newton	Poania, Colorado
I. M. Hawley	Salt Lake City, Utah
A. P. Sturtevant	Laramie, Wyoming
Leonard Haseman	Columbia, Mo.
Wilber G. Fish	Ithaca, New York
Leslie B. Daniels	Fort Collins, Colorado
Geo. M. List	Fort Collins, Colorado
F. T. Cowan	Fort Collins, Colorado
C. R. Jones	Fort Collins, Colorado
R. G. Richmond	Fort Collins, Colorado
Bernard Travis	Fort Collins, Colorado
Elwood H. Sheppard	Reading, Minn.
C. L. Corkins	Laramie, Wyoming

A total of ten sessions were held during the week for discussion and papers. These meetings were all very informal which led to a very free discussion of all topics and the subjects listed below give only an indication of the various ones that came up for consideration.

Onion Insects of Iowa—C. J. Drake

Importance of Insect Physiology and Morphology—Leonard Haseman

The Rose Snout Beetle—J. L. Hoerner

The Potato Flea Beetle—L. B. Daniels

The Work of the United States Bureau of Entomology, and the Mediterranean Fruit Fly Situation—C. L. Marlatt

New or Outstanding Insects of the Year—L. Haseman, J. H. Newton, C. J. Drake, G. I. Reeves, A. W. Lindquist, B. Liston, R. Potter, W. A. Shands, F. T. Cowan, S. C. McCampbell, C. P. Gillette.

The Beet Leaf-hopper—W. A. Shands.

The Control Campaign Against the Mormon Cricket—F. T. Cowan

Symposium—Research in Entomology.
Training for Research—C. P. Gillette
Organization for Research—C. L. Marlatt
Opportunities in Research—W. H. Larrimer
What is Wrong in Entomological Research—The Youngsters
Generic and Specific Characters of Aphids—M. A. Palmer
Early Notes on Colorado Insects—C. P. Gillette
Alfalfa Weevil Population—J. C. Hamlin
Notes on the Alfalfa Weevil—I. M. Hawley
Food Habits of the Agricultural Ant—C. R. Jones
Red Clover Pollenization—R. G. Richmond
Temperature and Humidity Control Boxes—T. A. Brindley
Work of the Intermountain Bee Station—A. P. Sturtevant
Metabolism Studies of the Honey Bee—C. L. Corkins
Cherry Insects of Northern Colorado—Geo. M. List
Some External Parasites of the Rodent Family Sciuridae, in Colorado—S. C. McCampbell
Heat, Caramelization and Regranulations of Honey—R. G. Richmond

Insect collecting, fishing, horse-shoes, and miniature golf were the chief diversions. One entire day was given for the longer mountain trips and for those that collected and fished most earnestly. Mr. Bernard Liston won the miniature golf tournament for men and Mrs. Liston won it for the ladies. This offered probably the keenest competition of any of the sports. The regular golfers, especially Dr. C. L. Marlatt and Dr. C. J. Drake, were much chagrined to see the prize taken by a beginner.

Dr. C. J. Drake won the horse-shoe pitching contest but only after Dr. Leonard Haseman withdrew from the contest because mule shoes were not permitted.

Dr. W. H. Larrimer was the most persistent and successful fisherman and largely through his efforts the entire crowd was furnished mountain trout for three meals. As a matter of record it might be stated that his largest one was 15½ inches while the one caught by Dr. Marlatt in his initial attempt to cast a fly, was not over 12½ inches.

A more complete report of the meeting, which will give a short summary of each paper, will be mimeographed and sent to those that have attended the Conference in the past and any others that may request it.

The officers elected for 1931 were C. P. Gillette, Chairman; Geo. I. Reeves, Vice-Chairman; Geo. M. List, Secretary; C. R. Jones, Treasurer.

GEO. M. LIST, *Secretary*

Scientific Notes

Argentine Ant in Maryland. Ants collected on February 6, 1930, at the Clifton Park Greenhouses, Baltimore, Maryland, were identified by Dr. M. R. Smith, A. & M. College, Mississippi, as *Iridomyrmex humilis*. Since then the ant has been found in the Druid Hill Park and Carroll Park greenhouses, but an examination of commercial greenhouses has failed to reveal its presence in any of them.

ERNEST N. CORY, *State Entomologist, College Park, Maryland*

Clover weevils become injurious to beans. During the latter part of July our attention was called to three cases of serious injury to beans caused by the clover weevils, *Hypera meles* Fab. and *H. nigrirostris* Fab. These outbreaks were at Rush, Odessa, and near Trumansburg, N. Y. In each case the injury was most severe in the part of the field adjacent to a hay barn. It seems probable that the beetles were carried into the barn with clover hay and that on escaping from the building they were forced to feed on the beans. We have been unable to find a record of beans being a food plant of these weevils. The beetles ate holes in the pods, in the stems and petioles, causing the leaves to wilt down and die.

C. R. CROSBY and W. E. BLAUVELT. *Ithaca, New York*

Silkworms and Their Parasites in New Caledonia.—Dr. Jean Risbec, of Noumea, New Caledonia, writes me that a colonist living at Yaté, New Caledonia, recently undertook to introduce silkworms, with the idea of establishing a silk industry. To his surprise, they were severely attacked by Hymenopterous parasites which were already present in New Caledonia. Dr. Risbec sends me specimens of these. One is *Chalcis falsosa* Vachal, described from New Caledonia. There are two males and a female of a fine bright ferruginous *Lissopimpla*, with partly black abdomen. This is very different from *L. semipunctata* Kirby (*Notiopimpla priosnemidea* Vachal), recorded in 1907 from New Caledonia. It may be *L. pacifica* Morley, of which I lack the description. Another genus of Pimplines is represented by two males, which I cannot place without females.

T. D. A. COCKERELL, *Boulder, Colorado*

A Note on two Hymenopterous Parasites of *Diatraea saccharalis* Fab.—Specimens from Tucumán and Güemes, Argentina, some of which were collected as adults in sugarcane fields, some reared from cocoons found in corn, and one reared from a Diatraea larva collected in corn, were determined by Mr. R. A. Cushman as *Bassus stigmaterus* Cress. Four other specimens reared from cocoons found in Diatraea tunnels in corn at Moncada, Peru, were also determined as *B. stigmaterus*. Previously, this species has been reported only from Cuba. It does not appear to be very abundant either in the Argentine or in the sections of Peru visited.

Two adults reared from cocoons found in very small Diatraea tunnels in corn at Tucumán were determined by Mr. Cushman as *Apanteles xanthopus* Ashm. I believe this is the first time that this species has been reported as a parasite of *Diatraea saccharalis* Fabr.

H. A. JAYNES, *Bureau of Entomology, U. S. Dept. of Agriculture, Tucuman, Argentina*

Dicymolomia julianis **Walk. Predatory upon Bagworm Eggs.**—*Dicymolomia julianis* Walk., a Pyralid moth, has been reared a number of times by the writer from egg masses of the bagworm, *Thryidopteryx ephemeraeformis* Haworth. The larvae were found feeding in egg masses which were all eaten by the time larval maturity was reached. Two larvae were discovered in dried pupal skins. They fed readily upon bagworm eggs, but failed to pupate, so positive identification was impossible. This would be more in keeping with the scavenger habits of *D. julianis*, as it ordinarily feeds in Typha heads. Possibly this may presage a change in food habits as it is unlikely that it is entirely a matter of chance that the larva of *D. julianis* is found in egg masses of the bagworm.

The only previous record in the literature is also from College Park, Maryland. In the Journal of Economic Entomology, Vol. 2, pages 236–237, 1909, A. B. Gahan states that he reared *D. julianis* from eggs of the bagworm. His observations were practically the same as those made by the writer. The authenticity of Gahan's observations has been questioned. It is therefore of interest to call this record to the attention of entomologists.

The specimens of *D. julianis* were determined by Mr. Carl Heinrich of the United States National Museum.

DONALD MCCREARY, *Department of Entomology, University of Maryland, College Park*

Nicotine in Paint for Woolly Aphis Control.—Due to the fact that woolly apple aphis predisposes callus tissue on pruning wounds and canker surgically treated, to perennial canker infection—*Gloeosporium perennans* Zeller and Childs, various painting treatments have been employed to control the insect. All paints that lift or crack as a result of the influence of the growing callus were found to be useless, in fact, paints that crack and lift offered protection to the aphids and the calluses treated often become more severely attacked due to the protection offered than is the case of untreated calluses. To exert a satisfactory influence on aphis control a paint must adhere closely to the growing callus and expand with the growth of the plant tissue. No paint applied in the spring has been found to meet, in all cases, this requirement though paints with a base as elastic as tanglefoot have been employed as well as a proprietary paint known as the Hood River tree paint.

Nicotine used in the form of Black Leaf 40 was found to greatly increase the efficiency of the applications which were made from paints employing tanglefoot and the Hood River tree paint—a rosin, fish oil-copper salts combination. The tanglefoot was diluted with both gasoline and carbon tetrachloride, used alone and together, to a point where it could be applied with a brush. The tree paint was diluted with gasoline. To these combinations the Black Leaf 40 was added in amounts of one part to four, one part to eight, and one part to sixteen in a number of tests. Complete control for the season resulted where the paints were diluted with one part of nicotine to four parts of the paints used. Control was satisfactory where the dilution of one to eight was employed and less effective with the one to sixteen dilution. Extensive infestation developed on the calluses where the paints were used without the addition of the Black Leaf. In limited tests nicotine has been recovered from paints at a period as long as nine months following the application. There is some evidence to the effect that the nicotine in the paint not only acts as a repellent to the aphis but as a contact poison to the young aphis as they seek out a location for establishment.

LEROY CHILDS

Two Leafhoppers of Apple and Prune in Southern Idaho and Eastern Oregon.—Leafhoppers are frequently very abundant in apple and prune orchards of southern Idaho and eastern Oregon. They feed on the under side of the leaves and a characteristic white flecking results from the feeding punctures. When the infestation is heavy the leaves become yellowish and injury to the tree results from the severe sapping of the leaves. Injury to the fruit consists of a stunted growth due to the reduced vitality of the tree, and of an unsightly spotting from the excrement of the leafhoppers.

Childs[1] has reported the rose leafhopper, *Empoa* (or *Typhlocyba*) *rosae* (Linn.) as a pest of apple in Oregon and the Pacific Northwest. Melander[2] has reported two species as common on apple in Washington: the apple leafhopper, *Empoasca mali* (LeBaron) and the rose leafhopper, *Empoa rosae* (Linn.). Edmundson[3] reported the apple leafhopper, *Empoasca mali* (LeBaron) as very common in Idaho.

Collections of leafhoppers were made during the summer of 1930 in numerous orchards of southern Idaho and eastern Oregon. Two species were found to be common on apple and one of these also common on prune. Some confusion has existed as to the identity of the two species occurring in this district. The white one has always been confused with *Typhlocyba rosae* (Linn.). Specimens were submitted to Dr. Dwight M. DeLong of Ohio State University, who determined them as *Empoasca maligna* (Walsh) and *Typhlocyba pomaria* (McA.).

Empoasca maligna (Walsh) is a light green leafhopper and was found to be common on apple at Parma, Fruitland, and Twin Falls in Idaho, and in the Malheur Valley of eastern Oregon. Single specimens were taken from cherry at Emmett, Idaho and from prune at Meridian, Idaho.

Typhlocyba pomaria (McA.) is a cream colored or whitish leafhopper found to be common on apple at Parma, Fruitland, and Twin Falls in Idaho, and in the Malheur Valley of eastern Oregon. This species was also common on prune at Parma and Meridian, Idaho, and in the Malheur Valley, Oregon.

The two species *Empoasca mali* (LeBaron) and *Typhlocyba rosae* (Linn.) did not occur in these collections from apple and prune.

ROWLAND W. HAEGELE, *Entomological Field Station,*
Idaho Agricultural Experiment Station, Parma, Idaho

The Efficiency of the Air-Blast Type of Sprayer for Applying Insecticides. Since the appearance of air-blast sprayers on the market, entomologists and fruit growers have raised the question of the efficiency of these machines for applying insecticides to fruit trees. As a result of many requests for information on this subject, an experiment was conducted to determine the value of the air-blast type of sprayer as compared with the ordinary power spray outfit for applying dormant sprays to peach trees for the control of the San Jose scale.

Lubricating-oil emulsion (67.67 per cent oil) at the rate of 9 gallons of the concentrate to 191 gallons of water, and liquid lime sulphur (32° Baumé) at the rate of 25 gallons of the concentrate to 175 gallons of water were used for the experiment. A tank-load of each insecticide was applied with an air-blast sprayer and with the ordinary power spray outfit. The spraying was done on an unusually calm day. On

[1]Leroy Childs, Bul. 148, Ore. Agr. Exp. Sta. 1918.
[2]A. L. Melander, Ext. Cir. 9, State Col. of Wn.
[3]W. C. Edmundson, Bul. 87, Univ. Ida. Agr. Exp. Sta. 1916.

account of the favorable conditions under which these tests were conducted, the results with the air-blast sprayer perhaps represent the best that can be expected from that machine. All of the spraying was done by laborers experienced in spraying with this type of outfit and the ordinary power spray outfit. The average percentages of control of the San Jose scale from the two insecticides therefore indicate the results to be obtained by the average grower in spraying for that insect.

Twenty record trees were selected in each plat. Scale counts were made from each of these trees just before the sprays were applied, and then again from the same trees one month after spraying. The results of the experiment are as follows:

Plat No.	Insecticide used	Applied with	Average per cent of scale alive before spraying (Feb. 19, 1930)	Average per cent of scale alive one month after spraying (Mar. 22, 1930)	Average per cent of control of the San Jose scale
I	Lubricating-oil emulsion (9–191)	Air-blast sprayer	75.8±0.91	3.1±0.79	95.9±0.98
II	Lubricating-oil emulsion (9–191)	Power spray outfit	76.4± .78	4.1± .66	94.7± .85
III	Liquid lime sulphur (25–175)	Air-blast sprayer	73.9±1.14	35.2±1.39	51.9±2.06
IV	Liquid lime sulphur (25–175)	Power spray outfit	76.0± .75	26.1± .79	65.7± .91

OLIVER I. SNAPP and JAMES R. THOMSON,
U. S. Peach Insect Laboratory, Fort Valley, Georgia

***Dichomeris piperatus* Walsingham, a Pest of Alfalfa in Puerto Rico.**—Carbohydrates as food for cattle are easily raised in Puerto Rico, but practically all the proteins fed to dairy cattle as concentrates on the Island are imported. The Department of Agriculture of Puerto Rico has demonstrated that alfalfa hay of the best quality can be produced at its Sub-Station in Isabela. According to Mr. L. A. Serrano, Director of this Sub-Station, a crop can be harvested every thirty-three days after the plantation is one year old and this yields some eight tons of dry hay per acre per year, which is as good or better than the production in many temperate climates. There are no data, however, as to the duration of alfalfa plantations under our tropical conditions.

Mr. Serrano does not believe that alfalfa could be grown as successfully in the more humid parts of the Island where heavier soils and rainfall would not allow it to produce the long tap root which is essential for its proper development and which the irrigated loose soils of the Isabela region make possible. But still, alfalfa hay could be produced in this region for the rest of the Island.

So far two important insect pests have attacked the alfalfa at Isabela. One is a Geometrid which appears during the winter months. The other becomes very abundant in the spring and is a Gelechiid, *Dichomeris piperatus* Walsingham, determined for us by Dr. William T. M. Forbes at present studying the Lepidoptera of the Island for the Scientific Survey of Porto Rico conducted by the New York Academy of Science. Dr. Forbes has given us the following notes and description:

The adult of *D. piperatus* is a small moth about one-fourth of an inch long, buff in color with three pairs of black dots on the wings. The front pair is not so well marked as the other two. The palpi have a large triangular second joint and a very

slender third, as in the Palmer worm and the diamond back moths. *D. piperatus* was described from St. Vincent and later bred from a legume in Saint Thomas, West Indies. The native host plant on which the insect breeds in Puerto Rico has not been determined yet. Adults have been collected in Puerto Rico at Santurce, Mar. 25–30 by Hoffmann, at Coamo Springs, Apr. 6–30, at Cataño, Apr. 21–30 and at Puerto Real (Vieques Island) April 29–30 by Drs. W. T. M. Forbes and M. D. Leonard.

The following are the references on *D. piperatus:* Proc. Zool. Soc. 1891, p. 526; and 1897, p. 86 for the larva (Gudmann).

FRANCISCO SEÍN, JR., *Ass't. Entomologist, Ins. Expt. Station, Rio Piedras, P. R.*

Evaluation of *Trichogramma* Liberations.—The liberations of *Trichogramma* against insect pests have not yet been definitely proven to be of practical value. In order that several factors that should be considered may be brought to the attention of those who for the first time undertake to make use of this parasite, the writer submits the following observation:

The effectiveness of liberations made for the purpose of hastening the building up of the parasite population is more difficult to determine than that of liberations made to effect immediate reduction in the host population. The first or *accretive* method is of necessity employed against pests of field crops; the second or *inundative* method against greenhouse and orchard pests.

For the employment of the accretive method it is necessary that the host deposit eggs continuously throughout the first half of the season so that eggs are always present in sufficient numbers at a time when a rapid increase in the number of parasites is most effective. Liberations should be made each season only when such conditions first occur. If such conditions are satisfactorily produced at various points by the use of attractants such as light or baits, population of parasites may be built up earlier. Because of the enormous plant surface of field crops, which form a more or less continuous cover and the comparative low value of the crops per acre, the cost of using any other method than that of accretion would be prohibitive.

The conditions under which the inundative method may be used are often quite the reverse. The plant surface is in most cases much less per acre and forms a broken or "island" cover. More parasites can be liberated per acre because of the high acreage value of the crop. Since in this case a small number of pests can do a great amount of injury and injury by the early generations is relatively great, reproduction of the host should be prevented by continuous liberations. In the control of the Oriental peach moth and codling moth, the eggs must be destroyed before the larva hatches and causes "stings" on the fruit. To accomplish this, parasites must be liberated at intervals timed so that the parasite is always present in numbers greatly exceeding that of the host population. The length of the life cycle of the parasite at field temperature must be ascertained. Since the oviposition of moths attacking fruit trees is more or less periodic, the amount of oviposition comparatively low and scattered in small clusters or singly, the accretive method would rarely be employed with success.

In determining the effectiveness of accretive liberations, it must be recognized that a low percentage of parasitism early in the season when the pest population is low may be more effective than a high percentage of parasitism late in the season when the pest population is high. This is due not only to the elimination of a great potential population but to the actual number ***not parasitized***. As the host population in-

creases the percentage value of parasitism decreases. For example, a 50 per cent parasitism of 20 hosts is equal in actual results to 90 per cent parasitism of 100 hosts.

The amount of parasitism is usually determined by observation of the host eggs in the field. Particular care must be taken in making the counts to maintain the actual ratio between the parasitized and unparasitized eggs.

In determining the effectiveness of inundative liberations a count of hatched eggs and vacated parasitized eggs should be made at short intervals throughout the season. The amount of injured fruit at each inspection should be correlated with the percentage of parasitism and total number of host eggs. Some idea of the effect of each liberation can then be obtained. Eggs that are counted should be rubbed off at the time of inspection.

From a practical standpoint, the percentage of parasitism means nothing when considered alone. When correlated with the size of the host population or the amount of crop injury, its economic value can be ascertained. Since the percentage of parasitism is supposedly the same for any part of the population as for the whole, it is obvious that the reduction in host population by natural mortality would not necessarily decrease the effectiveness of egg parasitism. In fact it would have the opposite effect.

In the case of field crops the effect of the natural egg parasitism on the total egg parasitism can only be measured by having numerous check fields throughout a wide area selected as far as possible to take in the extreme variations in natural parasitism. Should a colonized field over a period of years, or a number of colonized fields in a single season, consistently show a higher parasitism and greater reduction in crop injury than most of the checks, the control may be considered due to the liberations.

The checks should have a potential pest population approximately equal to that of the colonized field.

STANLEY E. FLANDERS,
Citrus Experiment Station, Riverside, California

JOURNAL OF ECONOMIC ENTOMOLOGY

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The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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ANNUAL SCIENTIFIC MEETINGS: 1930-31, Cleveland; 1931-32, probably New Orleans; 1932-33, Chicago; 1933-34, undecided; 1934-35, probably Rochester.

Drought relief has been a topic of Nation-wide interest during the last few months and as yet, comparatively little has appeared in the press in relation to the effect of drought upon trees. It is obvious that the immediate effects upon plant life and national prosperity are most evident in annual crops and it is certainly necessary to give due attention to this phase of the problem. Drought is not primarily an entomological problem, though lack of moisture may be favorable to a great increase in certain insects, such, for example, as the chinch bug. There is another phase of the drought problem which entomologists may well recognize, and that is the reduced vitality of trees accentuates injury by leaf eating insects, such as the elm leaf beetle and Japanese beetle and also brings about conditions favorable for invasion by various destructive borers. There is a real opportunity for entomologists in the drought affected areas to point out probabilities, so far as trees are concerned, both fruit trees and shade trees, since these indirect injuries are likely to develop over a period of several years, may have serious consequences so far as the life and vigor of highly prized trees are concerned, and on account of the time involved in the development of certain of these conditions, it is entirely possible to mitigate the evil, even though it may not be possible to entirely avoid it. The beauty and desirability of many residential areas is dependent in large measure upon thrifty shade trees. Many thousands of such trees have succumbed in the past to untoward conditions, and the present is a real opportunity for entomologists to aid in averting serious tree losses during the next few years.

Anna B. Comstock

Obituary

ANNA BOTSFORD COMSTOCK

Born Sept. 1, 1854; died Aug. 24, 1930

ANNA BOTSFORD COMSTOCK, born on a farm in western New York, spent the first ten years of her life among the fields and woods of a beautiful countryside. Here she learned the haunts and habits of the native wild life, came to love and foster the domestic animals of the farm and grew in sympathetic understanding of the problems of farm life.

Undoubtedly she inherited much of her love for nature from her rugged, kindly, wise father who in season followed the cool, wooded streams in quest of the speckled trout and in winter tramped the hills in company with his dog and gun in patient pursuit of the wily fox, while in the autumn, with the aid of his box of sweetened bait, he loved to trace the wild honeybee to her home in some far hollow tree. Being an only child, she became her father's companion in field and wood, where her contact with nature exerted a lifelong influence.

At the age of 16 she entered Chamberlain Institute at Randolph, N. Y. where she prepared for college, and in 1875 entered Cornell University, that young institution which admitted women on an equal footing with men.

Her she became acquainted with Professor John Henry Comstock, and in 1878 they were married. In 1879 Professor Comstock went to Washington as Entomologist of the Department of Agriculture. In this capacity he became interested in the Coccidae and being unable to find an artist who could interpret and depict microscopic structures, he enlisted the talent of Mrs. Comstock who then began the study of the pygidea of scale insects under his direction. She soon proved able to make the drawings which illustrated his classic papers on these insects. Thus she became a student of entomology.

When they returned to Cornell, Mrs. Comstock entered enthusiastically into the work of her husband and began to study the art of wood engraving in order to illustrate the well-known Comstock Manual for the Study of Insects. She soon became a notable artist, especially in her work representing the delicate texture of the bodies and wings of butterflies. Presently, in recognition of her work, she was elected a member of the Society of American Wood Engravers and at the Buffalo Exposition in 1901 her engravings were awarded the Bronze Medal.

In 1896, when the movement in nature study was inaugurated at Cornell, she was asked to assist in the work and was made Assistant in Nature Studies in 1897. In 1907 she became Instructor in Nature Study, in 1913 Assistant Professor, and in 1920 Professor of Nature Study. She became imbued with the idea of awakening within the child a love for the beauties and wonders of nature found in every countryside and on every farm, to the end that this child might eventually become a better, happier, more contented and wiser farm man or farm woman. Out of this fervor came the "Handbook of Nature Study," a volume of over 900 pages which has gone through 15 editions and serves as a text in the schools of every State in this country. In addition it is in use in Japan, China, England, Alaska, Australia and Canada.

Mrs. Comstock also served as editor of the *Nature Study Review* for several years, at the same time contributing many articles on nature subjects to other periodicals. She was the author of several books in addition to the Handbook. These include: Ways of the Six-footed; How to Know the Butterflies (with her husband); How to Keep Bees; The Pet Book; Confessions to a Heathen Idol (a novel); and Bird, Animal, Tree and Plant Notebooks.

She was an Associate Director of the American Nature Association, a member of the Society of American Wood Engravers, a Trustee of Hobart and William Smith Colleges, a member of Sigma Xi and of Kappa Alpha Theta Sorority. In 1923 she was chosen by the National League of Women Voters as one of the 12 greatest living American women.

Perhaps Mrs. Comstock is best known and endeared to many readers of the JOURNAL from the fact that they have been entertained in her home, which for 40 years was a rendezvous for all of Professor Comstock's students. Here she received and entertained with that gracious sympathy and understanding that made every guest a real participant in the life of a lovely home.

G. W. H.

Reviews

The Coconut Moth in Fiji, A History of Its Control by Means of Parasites by J. D. TOTHILL, T. H. C. TAYLOR and R. W. PAINE, pages I–VII, 1–269, 34 plates, a number colored, 119 text figures. Imperial Bureau of Entomology, London, 1930.

This is a most interesting, well written account of a successful attempt to control a serious enemy of coconut, *Levuana iridescens*. A Levuana Committee was organized and after consultation with Dr. G. A. K. Marshall, Director of the Imperial Bureau of Entomology, arrangements were made for the employment of an entomologist and the creation of an organization to make a comprehensive study of the problem, in an effort to secure practical control. The outcome is a striking testimonial of the possibilities of biological control under certain conditions. All responsible for the work are to be congratulated most highly upon its successful outcome.

This volume presents a brief historical account of previous work, a detailed description of the campaign instituted in January 1925, a comprehensive study of the Levuana moth, of the Tachinia fly, *Ptychomyia remota*, and in addition there are studies of allied Zygaenids, of certain parasites of this group and an account of the predaceous beetle, *Callimerus arcufer*. The comprehensive character of the study may well serve as a model for future investigations of this nature and under the relatively simple biological conditions obtaining on many of the Pacific Islands, one may be justified in believing that in such sections biological control is an exceptionally promising method.

E. P. F.

Current Notes

On July 25 Dr. E. W. Dunnam, Bureau of Entomology was reappointed Entomologist with headquarters at Bryan, Tex.

Dr. Wm. H. Mitchell, Jr., accompanied Dr. A. C. Baker to Honolulu, where he will be engaged in research work on the Mediterranean fruit fly.

Prof. W. B. Herms returned to Berkeley on September 10 after giving a series of lectures at the summer session of the Ohio State University.

Everard E. Blanchard, Entomologist, Ministry of Agriculture, Argentina, and Dr. C. H. Richardson, Iowa State College, visited at the University of California early in September.

Prof. E. O. Essig of the University of California has been elected a life honorary member of the California State Association of County Agricultural Commissioners.

Harry M. Jennison and E. K. Bynum have been given temporary appointments as Field Assistants, Bureau of Entomology, for service at Bozeman, Mont., and Phibodaux, La., respectively.

Dr. William Morton Wheeler, for many years dean of Bussey Institution, received the honorary degree of Doctor of Science from Harvard University at its recent commencement.

J. A. Parventjev, of the Pathological Institute, Berlin, Germany, visited the Cotton Insect field laboratory at Tallulah, La., on July 5, to confer with Mr. Coad regarding insecticides.

Dr. W. E. Britton, State Entomologist of Connecticut, received the honorary degree of Doctor of Science from his Alma Mater, the University of New Hampshire, on June 16.

L. H. Dunn, of the Gorgas Memorial Laboratory, Panama City, Panama, spent July 7 to 14 at the Museum, studying the blood-sucking flies, mostly Tabanidae and Simuliidae, in the collections.

Archie Rolfs, a recent graduate of Iowa Agricultural College has been appointed Junior Entomologist, Bureau of Entomology, and reported June 5 for duty at the field laboratory at Yakima, Wash.

W. C. Wooding, Jr., who was employed during July and August at the field laboratory at Danville, Va., has left the service to continue his studies at the University of Virginia.

M. C. Lane of the Bureau of Entomology, Walla Walla, Wash., visited Blairmore, Alberta, Canada, August 27 and 28, where he conferred with Canadian entomologists and others regarding investigations of the wireworm.

L. B. Reed, Bureau of Entomology, who has been investigating the sweet-potato weevil at Picayune, Miss., was recently transferred to Chadbourn, N. C., to assist in investigations on the strawberry root aphid.

Dr. F. Silvestri, of Portici, Italy, visited the field laboratory, Bureau of Entomology, at Yakima, July 3 to 5. On July 4 he was taken on a collecting trip in the mountains west of Yakima.

Temporary appointments as Field Assistants, Bureau of Entomology have been given to R. S. Lehman, for service at Walla Walla, Wash., M. V. Lowe, at Chadbourn, N. C., and C. E. Woodworth, at Madison, Wis.

Dr. C. A. Weigel, Bureau of Entomology, spent August 26 to 29 in Babylon, L. I., taking part in the inauguration of the heat and vapor treatments of narcissus and other bulbous stocks being conducted there.

Mr. H. L. Caler, a recent graduate of the University of Maine, holds the Volck Fellowship (in Entomology) of the Crop Protection Institute at the Kansas State Agricultural College for the current school year.

Mr. B. R. Coad, Bureau of Entomology has gone on an extended western trip, to last probably two months, during which he will visit the field laboratories dealing with cotton insects occurring in western Texas, Mexico, Arizona, and California.

Professor and Mrs. Geo. A. Dean of Manhattan, Kansas, expect to sail from Cherbourg, France, on September 20th, on the "Empress of Scotland," arriving at Quebec on Sept. 27th. They report a very pleasant and profitable sojourn in Europe.

Mr. Ralph Hopping, Entomological Branch, inspected areas in the Grand Forks Trail district, B. C., where the tussock moth, *Hemerocampa pseudotsugata* McD., is epidemic. This insect has increased tremendously during the present year, resulting in severe damage to Douglas fir.

Dr. Wm. H. Mitchell, jr., of the Plant Quarantine and Control Administration, Bureau of Entomology, spent several days in Washington immediately prior to leaving on July 31 for Honolulu, where he will be engaged in research work on the Mediterranean fruit fly.

In New Brunswick, Canada, scouting for the European apple sucker was completed on June 13. As a result of this work it was established that there has been very little spread of the insect beyond the limits of infestation found last year.

Rodney Cecil, Bureau of Entomology, who has been in charge of the field laboratory at Geneva, N. Y., for the study of the Mexican bean beetle, was transferred August 24 to Alhambra, Calif., where he will inaugurate work on the lima-bean pod borer.

On July 1, Doctor W. W. Henderson took the place of the late Doctor Herbert J. Pack as Station Entomologist at the Utah Agricultural Experiment Station. C. J. Sorenson and G. F. Knowlton were advanced from the rank of Assistant to Associate Entomologist, on the same date.

On July 1, Ralph E. Kimport, Agent, Bureau of Entomology, was transferred to this division from the Plant Quarantine and Control Administration, and assigned to a newly established field laboratory at Bay Shore, Long Island, a branch of the Corn Borer Laboratory at Arlington, Mass.

H. A. Jaynes, Bureau of Entomology, stationed in Peru, has sent to New Orleans during the summer almost 170,000 parasites of the sugarcane moth borer. Most of these were the dipterous species *Paratheresia claripalpis*, but there were 10,000 specimens of a species of Ipobracon.

On the first of July, Professor Ray Hutson formerly of Rutgers University, New Brunswick, New Jersey, took up his duties as Associate Professor of Entomology at Michigan State College. Professor Hutson is also a Research Associate of the Experiment Station.

A class in entomology of the University of California spent six weeks during the past summer in the High Sierras, 7000 feet altitude, collecting insects. This summer field trip is a regular thing and required of all students in the Division of Entomology and Parasitology.

A. O. Larson, Bureau of Entomology, who has been in charge of investigations of the bean weevil in California, has been transferred to the Pacific Northwest, where he has been placed in charge of investigations of the pea weevil, with headquarters at the Oregon Agricultural Experiment Station at Corvallis.

Dr. A. C. Baker, Bureau of Entomology, after making a brief stop at the field laboratory at Whittier, Calif., for a conference with the members of the staff there, sailed from Los Angeles August 9 for Honolulu, to reorganize the field laboratory there.

Dr. A. A. Granovsky, of the University of Wisconsin, has accepted an associate professorship in Entomology at the University of Minnesota. Apart from his work on the ecological aspects of insect control, his major problem will be the study of insect transmission of plant diseases, in cooperation with Dr. J. G. Leach, of the Division of Plant Pathology.

Mr. E. B. Watson, Entomological Branch, left Ottawa for the north shore of the St. Lawrence river, Que., on June 9, to continue biological studies on the hemlock looper. Messrs. M. B. Dunn and H. Fleming established a field station at Laniel in the Kippewa district Que., in mid-June, where they are to conduct investigations on the jackpine sawfly infestation.

Mr. Geo. R. Hopping, Entomological Branch, has had charge of airplane dusting operations against the hemlock looper and hemlock tip moth in Stanley park, Vancouver, B. C. The project was sponsored and financed by the Vancouver Parks Board, and the dusting work was commenced on June 15 using flying boats of the Western Canada Airways. The insecticide used was calcium arsenate.

Recoveries have been made this year from points about Boston and Revere, Mass., where colonies of a tachinid, *Chaetexorista javana* B. and B., were put out in 1929. This tachinid is a parasite of the oriental hag moth, *Cnidocampa flavescens* Walk., and the material from which the colonies were obtained was sent from Japan by T. R. Gardner, of the Japanese-Beetle Project.

M. McPhail and C. B. Keck were transferred to the Plant Quarantine and Control Administration, as of August 1, and left Orlando, Fla., for Honolulu, to join the research workers on the Mediterranean fruit fly. En route they stopped at Whittier, Calif., to look over the equipment at the laboratory there. Ralph Marlowe, formerly connected with the research work at Orlando, will also join the staff at Honolulu.

John Gray has been appointed Entomologist, pending certification, and assigned to the study of the ecology of the oriental fruit moth, with headquarters at Moorestown, N. J. Dr. Gray was formerly Professor of Entomology and Plant Pathology at the University of Florida, and has recently received a doctor's degree from Cornell University.

Dr. H. E. Ewing, of the taxonomic unit, Bureau of Entomology reports that as a result of his work in the field during the summer he has discovered two interesting new hosts for the chigger—the mud turtle and the leopard frog. The chigger has been previously found on the box turtle.

Mr. Arthur Gibson, Dominion Entomologist, sailed for England from Montreal, on the S. S. Duchess of Bedford, on June 6, to attend the Third Imperial Entomological Conference held in London, June 17–27. He also was present at the World's Poultry Congress, London, July 22–30, and presented a paper on insect and other external parasites of poultry in Canada.

G. J. Haeussler, Bureau of Entomology, who is investigating parasites of the oriental fruit moth, with headquarters at Antibes, France, reports that several parasites of this insect are present in southern Europe, but are relatively lacking in abundance. He has begun mass rearing of a species of Pristomerus for shipment to the United States.

At the request of the county agents of Cook, Laurens and Lanier Counties, Ga., S. E. McClendon, Bureau of Entomology gave them assistance in August in their work of controlling the corn weevil. Weevils will have a hard time in the western parts of Georgia and South Carolina, where drought is reported to have ruined the corn crop.

Temporary appointments as Field Assistants, Bureau of Entomology, effective July 1, were given to Hugh S. Cavitt, E. F. Knipling, H. B. Tittle, and H. L. Teer, for service at El Paso, Tex., and to S. F. Davis, M. C. Ewing, B. A. Kennedy, W. L. Lowry, H. T. Rainwater, K. R. Vance, Geo. M. Webb, D. H. Allen, jr., and W. H. Lindley, for service at Tallulah, La.

O. C. McBride was transferred from the Bureau of Entomology to the Plant Quarantine and Control Administration, effective August 15, and left Orlando, Fla., on August 25 en route for Honolulu, where he will be in charge of the work being organized there on the Mediterranean fruit fly. This work is to be carried on under the direction of the Bureau of Entomology, but paid for by funds provided by the Plant Quarantine and Control Administration.

Late in June, Mr. R. P. Gorham, Entomological Branch, of the Fredericton laboratory, discovered an infestation of the satin moth at Annapolis Royal, N. S., and a few days later outbreaks were reported in Moncton, N. B. A survey has been commenced to ascertain the extent of these outbreaks and the possible presence of others in the Maritime Provinces. This insect was previously known to occur only in British Columbia, where it was first discovered in July, 1920.

The field laboratory for the investigation of pecan insects at Albany, Ga., formerly located at 515 Flint Street, has been moved to 1503 Jefferson Street. The entomological laboratory is situated in one section of a new two-story brick building, recently constructed by the Chamber of Commerce for all pecan investigations. The building is being occupied not only by the Bureau of Entomology, but also by the division of Horticulture and Plant Pathology of the Bureau of Plant Industry, and the Bureau of Chemistry and Soils.

Professor Filippo Silvestri, head of the Agricultural Institute of Portici, Italy, spent August 28 at Tallulah, where he was shown through the various departments of the field laboratory. He was especially interested in the dusting of cotton by airplanes, and was enthusiastic in his praise of the laboratory's scientific equipment and the extent of its operations. His visit to the South was intended particularly to study at first hand the cane borer and the boll weevil. Before sailing for Italy, at the end of September, Professor Silvestri will visit Columbus, Ohio, the Experiment Stations of New Jersey and Massachusetts, and the Department of Agriculture, at Washington, D. C.

R. A. St. George, Bureau of Entomology, left Asheville, N. C., on July 18 for an assignment at Wisdom, Mont., to determine the practicability of killing *Dendroctonus monticolae* Hopk. in infested lodgepole pines by injecting poison into the trees. A saw is used to make a cut of sufficient size for receiving the poison. Trial will be made for several poisons which were found most promising in experiment work done at Asheville last year, in connection with shortleaf pines infested by the southern pine beetle (*Dendroctonus frontalis* Zimm.). The primary object of the experiment is to find a less expensive method of treating infested trees than the methods in use at the present time. Studies in the medication of trees are being continued at Asheville with pine and with certain hardwoods, and some interesting results have been obtained.

As the result of a two-year investigation of alfalfa meal mills by the Salt Lake station of the U. S. Bureau of Entomology, during which it was shown that alfalfa weevils do not tend to accumulate in the vicinity of mills and that no special precautions are necessary to prevent contamination of meal after grinding, the Western Plant Quarantine Board at its annual meeting in June, 1930, recommended the removal of the embargo maintained by the western states upon the shipment of meal during the summer months. This action follows the delivery at the 1929 meeting of the Board of papers by Doctors Hamlin and Hawley giving a resume of the investi-

gation. These papers were approved for publication by the Bureau of Entomology in October, 1929, and will doubtless be published with the Proceedings in the Monthly Bulletin of the California Department of Agriculture.

Approximately 35,000 adults of the parasite *Macrocentrus ancylivora* have been reared and distributed from the oriental fruit moth field laboratory at Moorestown, N. J., in this season. They were liberated in 70 colonies in important peach-growing centers east of the Mississippi River in which this parasite had not previously been found. In this program, and in supplementary projects undertaken by the Canadian Government and by several States, this laboratory has worked in close cooperation with a number of others. The entomological services of those States have cooperated actively in the work of distribution and recovery. Several States have undertaken mass rearing of this valuable parasite from parasitized material collected in New Jersey. To meet the demand, an additional 400,000 parasitized larvae have been collected and shipped from this center under the supervision of this laboratory. Numerous recoveries have been made and the results to date seem very promising.

On July 3, Congress approved an item of $50,000 for the purchase by the Department of Agriculture of the collection of Lepidoptera built up by the late Dr. William Barnes, of Decatur, Ill. This collection, which is world famous, comprises more than 450,000 specimens, including many types and other accurately compared specimens, and is accompanied by a large library on Lepidoptera and by an extensive card catalog of the North American species. The collection arrived in Washington on the afternoon of August 8, after having been packed and shipped from Decatur, Ill., under the supervision of Messrs. Heinrich and Busck, of the Bureau staff. The collection and accessories made a load of about 45,000 pounds practically filling a large express car and presenting serious difficulties in the matter of proper handling. The collection arrived in excellent condition and is already placed in the National Museum, and so is available for reference and study.

After 31 years of continuous service as head of the Department of Entomology at the Massachusetts Agricultural College, Dr. Henry T. Fernald retired on July 1st, 1930 to devote his time to his study of the Sphecoidean wasps and other researches in Entomology. For administrative purposes, the Departments of Entomology, Zoology and Geology have been combined into a single major department, with Dr. Clarence E. Gordon, Professor of Zoology and Geology, as head. Dr. Charles P. Alexander has been promoted to a full professorship, in charge of the college instruction in Entomology. Dr. G. Chester Crampton continues in charge of all work in Insect Morphology and Phylogeny. Assistant Professor Arthur I. Bourne has been made a Professor, in charge of the research in the Agricultural Experiment Station. Mr. Clayton L. Farrar has been promoted from Instructor in Apiculture to Assistant Professor, and Dr. Harvey L. Sweetman has been appointed Assistant Professor, in charge of the courses in Insect Ecology and Physiology. Dr. Fernald will remain at Amherst until about October 1st, but thereafter will reside at 707 East Concord Avenue, Orlando, Florida.

Starting early Monday morning, July 21 from Maryland approximately forty Maryland growers, County Agents, and specialists gathered at the Japanese Beetle Laboratory at Moorestown, where they were greeted by Dr. Fox and Dr. King who are in charge of the laboratory. The specialists concerned with the different phases of the Japanese beetle situation addressed the assembled Marylanders and then an opportunity was given them to observe the experimental work in progress on soil

treatment, parasite rearing, and other phases of the work. One of the striking things observed was the catch of beetles by five hundred traps that had been in operation fifteen days on a fifteen acre estate north of Philadelphia. A total of five barrels of beetles had been collected in that time. In the afternoon the party proceeded to the vicinity of Mullica Hill where extreme foliage injury to fruit trees and ornamental trees was observed. Spraying operations with poison geraniol sprays designed to attract the beetles into apple trees and kill them when they fed upon the poisoned material were watched with much interest.

On July 28th the following men gathered at the University of Maryland to examine the Mexican bean beetle control experiments being conducted on the Maryland Experimental Farm near Beltsville by Dr. Langford and Mr. Sanders: Dr. Neale F. Howard and W. H. White of the U. S. Bureau of Entomology, Dr. C. C. Howes, Davison Chemical Company; McSherry Lupton, John Bean Manufacturing Company; Dr. R. C. Roark, C. R. Smith, and Mr. Dearborn, Insecticide Division, Bureau of Chemistry; R. C. Burdette, Rutgers College; M. C. Morton, Central Chemical Company; and H. A. Hunter, Canning Crop Pathologist, University of Maryland. Forty-five one-twentieth acre plots were examined from the standpoint of beetle control and plant injury. The sprayed plots included the usual arsenical applications alone and in combinations with various adhesives and Bordeaux; also a similar series using barium fluosilicate, sodium fluosilicate and cryolite. A large series of dusting experiments were of much interest. New fluoride compounds developed by Dr. Roark and Dr. Howes were under test. Each plot contained four rows with the records being taken from the two middle rows.

From June 8 to July 7 (1930) Professor Franklin Sherman, with Mrs. Sherman and two of their children, Joseph and Grace, made a long auto tour from Clemson College, S. C., which was partly recreational, partly to attend to matters of the Association of Economic Entomologists and its meetings of next winter at Cleveland, and partly to visit departments of Entomology and Zoology at various places. By previous arrangement consultations were held at many institutions while others were viewed or visited more casually by driving through the grounds and among the buildings. Among the places visited were, Berea College in Kentucky, University of Kentucky, Ohio Experiment Station, Michigan State College, University of Michigan, Ontario Agricultural College at Guelph, University of Toronto, Queen's University at Kingston, Dominion Entomological Branch in Ottawa, Dominion Central Experimental Farms, Canadian National Museum, City of Quebec, Museum of Comparative Zoology at Harvard University, U. S. Gipsy Moth Offices, Massachusetts Agricultural College, Amherst College, Bronx Zoological Park, West Point, Cornell University, Smithsonian Institution, and North Carolina State Department of Agriculture.

The tenth annual meeting of the International Great Plains Crop Pest Committee was held under the auspices of the Lethbridge Dominion Entomological Laboratory on August 28–30, 1930. The meetings were held at the Greenhill Hotel, Blairmore, Alberta. The following men attended the meetings: Mr. H. G. Crawford, Chief of the Division of Field Crop and Garden Insects, Dominion Entomological Branch, Ottawa, Ontario; Prof. R. A. Cooley and Mr. G. A. Mail, of the Montana Experiment Station, Bozeman, Montana; Dr. J. R. Parker of the U. S. Bureau of Entomology, Bozeman, Montana; Dr. M. C. Lane of the U. S. Bureau of Entomology, Walla Walla, Washington; Prof. E. H. Strickland, University of Alberta, Edmonton;

Mr. S. H. Vigor, Field Crops Commissioner, Saskatchewan, Dept. of Agriculture, Regina, Saskatchewan; Messrs. N. Criddle and R. H. Handford, Dominion Entomological Laboratory, Treesbank, Manitoba; Mr. Brown of the Dominion Inspection Station, Estevan, Saskatchewan; Mr. K. E. Stewart, Dominion Entomological Laboratory, Indian Head, Saskatchewan; Messrs. K. M. King, E. McMillan and L. Paul of the Dominion Entomological Laboratory at Saskatoon, Saskatchewan; Mr. E. R. Buckell of the Dominion Entomological Laboratory at Vernon, B. C.; Mr. Eric Hearle, of the Dominion Entomological Laboratory at Kamloops, B. C.; Messrs, H. L. Seamans, G. F. Manson, C. W. Farstad, R. W. Salt, and J. H. Pepper, of the Dominion Entomological Laboratory at Lethbridge, Alberta. Dr. Niedig of the Consolidated Smelters, Trail, B. C. and Mr. F. S. Carr of Medicine Hat, Alberta, attended some of the sessions. Miss C. Coutts of the Dominion Entomological Laboratory of Lethbridge, Alberta, was secretary of the meetings. Several of the members were accompanied by their wives, and families.

Horticultural Inspection Notes

Mr. C. George Anderson has been transferred from New York to port inspection at San Juan, Porto Rico, effective September 1.

Mr. Marcus A. McMaster, formerly employed as a Junior Plant Quarantine Inspector, was reinstated August 25 for duty at the port of New York.

Mr. Herman T. Pinto received an appointment as Junior Plant Quarantine Inspector, effective July 16, and has been assigned to the port of El Paso, Texas.

Messrs. Claude E. Post and Pablo Ortiz received appointments as Junior Plant Quarantine Inspectors on July 16 and 21 respectively and have been assigned to the port of New York.

Mr. W. B. Wood of the District of Columbia inspection service, inspected imported date palms and certain special permit material being grown in southern Texas during the month of August.

Mr. L. S. McLaine, Chief of the Division of Foreign Pests Suppression of Canada, reports that the satin moth has been causing increasing injury in the southwestern part of British Columbia.

Mr. Robert L. Trigg was transferred from the port of New Orleans on June 27 and placed in charge of the port inspection work at Gulfport, Mississippi. Mr. R. W. Nicaise who has been stationed at the port of San Juan since 1928 has taken Mr. Trigg's place at New Orleans.

The Plant Quarantine and Control Administration has begun the issuance of a series of circulars giving the plant quarantine restrictions of various foreign countries. Those issued thus far relate to the requirements of Cuba (PQCA-283), Mexico (PQCA-284), and Italy (PQCA-289).

A European corn borer conference was held at Toledo, September 24 and 25, with headquarters at 615 Front St. The program included field trips, a business meeting, short talks, exhibits and demonstrations of the latest in implements and machinery.

The southern division of the American Phytopathological Society held its annual meeting and field trip in Mississippi, June 12 to 16. Among the subjects given special field attention were the bacterial canker disease of tomato, the phony disease of peach, and methods of dusting pecan orchards.

Drs. J. H. Montgomery and H. H. Hume of the State Plant Board of Florida, spent several days in Washington early in August, discussing with members of the Plant Quarantine and Control Administration, anticipated modifications of the State rules and regulations pertaining to the Mediterranean fruit fly.

The California State quarantine pertaining to Downy Mildew of Hop (No. 14) was revised effective July 11, 1930, to prohibit the entry of hop sets, hop roots or hop cuttings from Canada or from any State in the United States. Prior to this revision, the quarantine did not apply to entry of these materials from the State of Oregon.

Dr. Carlos Chardon, Commissioner of Agriculture and Labor, San Juan, P. R., who is the ex officio plant quarantine officer of that Territory, spent several weeks in Washington in September, attending the inter-American conference on agriculture, forestry and animal industry, and discussing various agricultural problems with members of the Federal Department of Agriculture.

The Federal European corn borer quarantine regulations were amended, effective August 1, to add to the regulated area all that part of New Hampshire which had not previously been included, and were again amended on August 20 to release from restriction shelled corn, the cut flowers or entire plants of cosmos, zinnia or hollyhock, as well as oat and rye straw and celery.

A hearing to give renewed consideration to the advisability of extending the Japanese beetle quarantine to include the State of Rhode Island has been announced by the Secretary of Agriculture, was held at the offices of the Plant Quarantine and Control Administration at Washington, D. C., on October 3. Immediately following the hearing there was a general conference on the Japanese beetle quarantine regulations.

The State Plant Board of Florida met at Jacksonville on August 11, 1930, to discuss the Mediterranean fruit fly quarantine regulations, and adopted a revision of the State regulations relating to the eradication of this pest and to the intrastate movement of restricted articles. The revised restrictions are closely coordinated with the Federal plant quarantine regulations but include many additional details relating particularly to fruit fly extermination.

The Federal Department of Agriculture on July 23 issued circular PQCA-285, calling to the special attention of permittees importing nursery stock for propagation under Regulation 14 of Quarantine 37, the importance of compliance with the requirements governing the segregation and labeling of imported plants. The requirement as to a map or chart showing the location of the imported stock will hereafter be required only when difficulty in locating the imported plants makes such a chart necessary.

An informal conference to give consideration to certain problems connected with the maintenance of road stations around the area regulated on account of the one-generation strain of the European corn borer was held in the offices of the Plant Quarantine and Control Administration on August 13. Many of the Mississippi

Valley and Lake States were represented, and communications on the subjects before the conference were received from the quarantine officers of most of the other States of that section.

A recent paper of interest to plant quarantine officials is "*Dasyscypha fusco-sanguinea* Rehm on Western White Pine, *Pinus monticola* Dougl.", by C. R. Stillinger, published in Phytopathology, June, 1929. Mr. Stillinger reports that this disease occurs on five-leafed pines in the white-pine belt of northern Idaho, northeastern Washington, and northwestern Montana, and is so similar to white-pine blister rust that on superficial examination one may be mistaken for the other. The disease has not previously been reported as an active parasite on western white pine. The paper gives methods of differentiating this disease from the blister rust.

The executive committee of the Eastern Plant Board held a meeting on July 22, at the Hotel Benjamin Franklin, Philadelphia. Members of the committee present included President T. J. Headlee, Dr. W. E. Britton, Dr. G. T. French, Dr. J. F. Adams, F. A. Bevan representing Dr. A. W. Gilbert, and Dr. E. N. Cory. Messrs. L. H. Worthley and C. H. Hadley of the United States Department of Agriculture, and G. S. Langford of the University of Maryland, were also present to take part in the discussions and make reports. Dr. J. F. Adams was appointed by the executive committee to fill out the unexpired term of Dr. W. A. McCubbin as representative on the National Plant Board.

An inter-American conference on agriculture, forestry and animal industry was held in the Pan American Building at Washington, D. C., September 8 to 20, 1930. In addition to many representatives of the United States Department of Agriculture and of Porto Rico, delegates registered from Mexico, Cuba, The Dominican Republic, Haiti, and from sixteen Central American and South American countries. Among these were a number of plant quarantine officers, and subjects relating to insect pests, plant diseases, and quarantine and control measures, elicited general discussions. The general subject of plant quarantine and control measures was presented to the conference in a paper prepared by Mr. Lee A. Strong.

Under State Proclamation No. 36, dated August 20, 1930, the Commissioner of Agriculture of Texas issued regulations governing the growing and marketing of cotton in the pink bollworm infested area of that State. The regulations control the storage and use of seed cotton, and the movement from the regulated zones to points outside, or from one county to another within the zones, of seed cotton, cottonseed, cotton lint, and other parts of the cotton plant. It is further required that operators of both cotton gins and cotton oil mills, located either within or outside the regulated areas shall obtain authorization from the State Entomologist before ginning cotton from the regulated zones or crushing cottonseed from these zones.

The State Plant Board of Mississippi reports increasing losses from bacterial canker of tomato in that State. Two papers on this subject are included in the Quarterly Bulletin of the Board for July, 1930, one by Mary K. Bryan, Associate Pathologist of the Federal Department of Agriculture, and the other by Dr. L. M. Fenner of the State Plant Board. The disease is said to be present in nineteen States and also to occur in Canada, Italy and Germany. It was first reported to the Board in 1925 and 1926, but is now being repeatedly reintroduced into Mississippi with contaminated tomato seed from northern sources of supply. The State Plant Board

has made out a list of seed sources which furnished cankerfree seed for the 1930 crop, and is now giving consideration to the possible methods of protecting the growers for the crop of 1931.

Appointments and transfers for the organization of transit inspection to aid in the enforcement of Federal domestic plant quarantines for the fall nursery stock shipping season, together with the points to which the men will be assigned, include the following: F. J. Baker, Chicago, Ill.; C. M. Chapman, Ogden, Utah; H. E. Crossley, Spokane, Wash.; W. J. Cullen, Chicago, Ill.; G. H. Curtis, New York City; B. A. Ganoung, Seattle, Wash.; A. J. Lambert, New York City; G. W. Nelson, Minneapolis, Minn.; Carl O. Peterson, Portland, Oregon; T. L. Thompson, Kansas City, Mo.; R. E. Wheeler, Omaha, Nebr. and George M. Whiting, Spokane, Wash.

The California State quarantine pertaining to the alfalfa weevil (No. 7) was revised effective June 20, 1930, to cover three essential changes. The county in Nebraska under quarantine for this insect was changed from Scotts Bluff to Sioux County. This change was based upon the fact that the infestation was found near a county line and it was originally assumed that it occurred in Scotts Bluff County. However, later it was found to be in Sioux County as now specified in the revised quarantine. The second change provides for the admittance during the entire year of alfalfa meal from mills unquestionably equipped to prevent contamination of the finished product during the summer months or the active period of the weevil. A further change provides for the admission of ornamental and nursery stock without the fumigation and certification formerly required at origin.

The New Jersey Department of Agriculture, in June, published Circular No. 182, by Nathaniel A. Back, entitled "A Study of the Economic Costs of Quarantines in New Jersey." The author concludes that the quarantines are responsible for taking approximately "one-fifth of the total net income of certain large nursery and greenhouse concerns" of New Jersey, but that "the spread of the regulated area, in conjunction with the perfection of more efficient and less costly methods of treatment for certification, has resulted and should continue to result in reduced costs to those affected by the quarantines in this State." The author says that no attempt is made to evaluate the quarantines; that is, to weigh the value of holding up the spread of the insects against the cost involved in the process. The publication was prepared before the quarantine on the Asiatic beetle was revoked, but in a footnote it is stated this does not affect the results set forth in the remainder of the study.

The California State Department of Agriculture has issued as special publication No. 99 a report of the pest interceptions at California port inspection points for 1929. The report shows the examination of 3,695 vessels, 62,917 passengers, and 5,934,256 parcels of horticultural imports at San Francisco; 4,758 vessels, 24,264 passengers, and 2,310,092 parcels of horticultural imports at San Pedro (the port of Los Angeles), and 829 vessels, 6,617 passengers, and 388,537 parcels of horticultural imports at San Diego. It also shows the inspection of 1,720 airplanes and 5,990 airplane passengers at San Diego, and 537,417 automobile and 3,782 train inspections. The list of species and hosts of insect pests and plant diseases includes 640 different species of insects, mites and other animal hosts, and 25 different species of fungi, bacteria and nematodes collected at the maritime ports, and about half as many interceptions at border stations are noted. The most important interceptions reported relate to the Mediterranean fruit fly, the melon fly, the cherry fruit fly, the Oriental fruit moth, the nut codling moth, the pink bollworm of cotton, the sweet potato weevil, the Japanese rose beetle, the camphor scale, the rose scale, the citrus

canker, and a number of other serious insects and diseases which do not occur in California, as well as many pests not of general distribution in that State.

Effective August 15, 1930, the Secretary of Agriculture issued a revision of the Federal Mediterranean fruit fly quarantine regulations, incorporating changes in and interpretations of the previous requirements which had been issued as administrative instructions, and in addition making a number of important changes of interest to growers and shippers. Among the changes of general interest are (1) the authorization of the movement of sterilized fruit and of unsterilized tomatoes, eggplants and lima and broad beans from the regulated area of Florida to the southern and western States throughout the entire shipping season or until further notice; (2) authorization to the State Plant Board to reduce the size of the infested area to include properties within one-half (in place of one) mile from points of infestation; (3) the discontinuance of the requirement of sterilization for fruit shipped to the middle western States from points outside the infested areas; (4) the addition of blackberries, dewberries, mulberries, cotton bolls and seed cotton to the list of products which are exempt from the fruit fly requirements; (5) the extension of the harvesting and marketing period of the commercial Florida citrus crop to June 15, 1931, and (6) the removal of the reshipment regulations under which the transportation of Florida host fruits and vegetables from the northeastern States to the middle West was restricted. All administrative instructions previously issued under Quarantine No. 68 were cancelled but the subject matter of those which related to methods of sterilization of citrus fruits and avocados was immediately reissued in condensed form as circulars PQCA-290 and PQCA-291.

The twelfth annual conference of the Western Plant Quarantine Board was held at State College, N. Mex., June 12 to 14, 1930. A number of resolutions were adopted relating, respectively, to commendation of the Mediterranean fruit fly eradication campaign in Florida; to surveys in other southern States for infestation of the same insect; to an indorsement of the pink bollworm eradication program, and of plans "looking to cooperation with the Republic of Mexico for the banishment of pink bollworm from this continent;" to the need for a comprehensive study in foreign countries of such pests as appear capable of causing important pest problems in the United States; to the desirability of having the Federal Department summarize available data on pest treatments and have investigations made to determine additional treatments which may be of value; to weed control; to the interstate control of shipments of honey bees; to the desirability of having the Federal Department prepare a compilation of legal data, statutes, court decisions, etc., which have been accumulated as a result of agricultural quarantine litigation in courts of the United States, and to the need of devoting greater attention to car cleaning and confining car loads of agricultural products to single-walled cars. Other subjects discussed included the report of the alfalfa meal committee, of which M. L. Dean of Idaho was Chairman, in which it was stated that the type of equipment necessary to safeguard against alfalfa weevil contamination is now in operation at one or more places. D. B. Mackie, Chairman of the committee on pest treatment, gave up-to-date information relative to the use of Ethylene oxide and chloropicrin. At the close of the meetings, Dr. H. L. Kent, President of the New Mexico College of Agriculture and Mechanic Arts, was elected Chairman for the ensuing year; A. G. Stephens, Entomologist of the State of Wyoming, Vice-Chairman; W. C. Jacobsen of the California Department of Agriculture, as Secretary and as representative on the National Plant Board with Dr. O. C. Bartlett, whose term of office has not yet expired.

Apicultural Notes

The Cornell Beekeeping Library is now receiving a large collection of Russian beekeeping literature by exchange with workers of that country.

Dr. M. Hajdak, formerly of the Institute of Beekeeping at Dol, Czechoslovakia, has been appointed Field Assistant at the Bee Culture Laboratory, Bureau of Entomology.

A. A. Woodrow, C. C. Gillette, Thomas White, and Charles J. Bangham, graduate students in apiculture at Cornell University, are spending the summer in apiary inspection work in New York State.

Norman E. Phillips has resigned his position in the Department of Zoology at Syracuse University and will take graduate work at Cornell University during the coming year.

"Beekeeping" by Prof. E. F. Phillips of Cornell University has just been issued in a Russian translation by A. S. Mikhailoff of the Tula Apiculture Experiment Station, under the editorship of F. Tunin of the same Station.

Professor E. F. Phillips took part in the program for beekeepers during Farmers Week at the University of Missouri in July and also in the meeting during Farmers Week at the Massachusetts Agricultural College on August 1.

Jes Dalton, of Kenner, La., Associate Editor of the Beekeepers' Item, visited the Bee Culture Laboratory on July 16 and 17, to confer with the members of the staff concerning various problems of interest to beekeepers in the Southern States.

A second manuscript volume of the personal Journal of Rev. L. L. Langstroth has recently been discovered by members of his family and has been placed in the Cornell Beekeeping Library. The transcription of the first volume is almost completed.

E. J. Dyce of the Ontario Agricultural College, who has been taking graduate work at Cornell University during the past year, has been granted a scholarship for next year so that he may continue his studies on the fermentation and granulation of honey.

Professor E. F. Phillips of Cornell University was recently elected to honorary membership in the Hungarian National Society for Bee Culture, on the occasion of the fiftieth anniversary of that Society. Prof. Enoch Zander of Erlangen and Prof. Ludwig Armbruster of Berlin-Dahlem were similarly honored.

Interest in bees for pollination has recently increased greatly in the fruit section of New York and several hundred more colonies than before have been moved into these areas. Mr. George H. Rea of Pennsylvania who was formerly Extension Specialist in Apiculture at the New York State College of Agriculture was appointed temporarily to assist the fruit growers in the proper care of these bees.

E. L. Sechrist, Bureau of Entomology returned on August 4 after visiting the cooperators who are helping in the studies on apiary management and costs of honey production, in Ohio, Iowa, Minnesota, and Michigan. This work is being done in cooperation with the Bureau of Agricultural Economics, and with the beekeeping specialists in the various States. Some of the State specialists in economics are also taking an active part in these studies.

Dr. Lloyd M. Bertholf, Field Assistant, Bureau of Entomology, at the Bee Culture Laboratory, resigned on August 20. Doctor Bertholf, in company with Mrs. Bertholf sailed on August 23 for Scotland, on his way to Munich, where for the coming year he will study with Doctor von Frisch under a National Research fellowship. En route, Doctor Bertholf will attend the meeting of the Apis Club International Conference, at London, on September 8 to 12, where he will deliver a lecture on the results of his recent experiments on the response of honeybees to light of different wave lengths.

W. B. Bray, one of the largest honey packers in New Zealand, executive of the National Beekeepers' Association of New Zealand, and owner and editor of the New Zealand Honey Producer, visited the Bee Culture Laboratory, Bureau of Entomology September 2 and 3. He is making an extended trip through Europe, Canada, and the United States, in the interest of honey marketing. Mr. Bray reports that through Government assistance New Zealand has made great strides in honey marketing, and he was particularly interested in learning what is being done in this country along that line. In the course of his stay in Washington he visited officials of the Bureau of Agricultural Economics and the Bureau of Chemistry and Soils.

At the request of Prof. Eric Millen, Provincial Apiarist, Ontario Agricultural College, Guelph, Dr. C. E. Burnside consulted with the apicultural staff of that institution and the provincial inspectors concerning the unusual conditions observed this season in colonies infected with European foulbrood. The conditions found in the diseased colonies were of such a nature that field diagnoses were made under great difficulty. To a certain extent similar difficulties have been experienced in the United States during the present season. In many cases it has been possible only by the use of the microscope to make definite diagnoses of European foulbrood, because of its close resemblance to American foulbrood. Doctor Burnside also consulted with the bacteriologists at the college.

The Maryland State Beekeepers' Association held its annual summer meeting at the Bee Culture Laboratory on July 19. In the forenoon members of the staff gave short talks. After a picnic lunch which was served in the laboratory grounds several contests were held. It has become an annual event at the summer meeting of the Maryland State Beekeepers' Association to choose "the best beekeeper in the State." The title was decided this year by the beekeeper catching the most live bees and placing them in a wide-mouthed bottle without getting stung. A. Howard Johnson, of Centerville, Md., President of the State Beekeepers' Association, carried off the honors. A contest was also held to test the skill of the beekeepers in identifying various diseases of bees, and was won by Harold L. Kelly, of Forest Glen, Md. Pathe News Motion Pictures made "talkies" during the contests.

Dr. Warren Whitcomb, Jr., of the Southern States Bee Culture Field Laboratory, Baton Rouge, La., reports that at the meeting of the State Association of Queen Breeders and Package Shippers, which was held in conjunction with the meeting of the Texas State Beekeepers' Association, at College Station July 28 and 29, the package producers were well pleased with the progress being made by the Southern States Bee Culture Field Laboratory in recommending a satisfactory and uniform cage which could be used indiscriminately by all shippers of package bees. Doctor Whitcomb says that the use of a uniform package by the shippers will eliminate a great deal of confusion in the package-bee business, and that it will particularly

enable the express companies to facilitate shipment. The cage that the laboratory has been working on is simple in construction, is therefore economical, and makes it possible to ship the bees with as little loss as the more expensive and complicated cages now being used by a number of shippers of package bees.

The Texas Beekeepers Association held their annual meeting at College Station, and enjoyed an appropriate program, prepared by Dr. S. W. Bilsing, Head of the Department of Entomology, A. & M. College and Dr. F. L. Thomas, Chief of the Division of Entomology, Texas Agricultural Experiment Station. While the key note of the meeting was co-operation, several papers on local practices were presented. Dr. E. G. LaMay, State Board of Health, presented a paper on the Violation of Pure Food Laws. Cecil Heard, and W. M. Whitney, of the State Inspection Service told of their work. H. B. Parks, Chief of the Division of Apiculture and E. W. Cothran, told of the research work in beekeeping. Dr. E. W. Paulson, Division of Economics, Texas Agricultural Experiment Station, discussed co-operative marketing. Dr. Warren Whitcomb, Southern Field Laboratory, U. S. D. A. Baton Rouge, La., explained the specifications adopted, by their station as standards for crates in which bees are shipped. The Association went on record, as continuing its support of the American Honey Producers League, The Honey Institute, and the Southern Beekeepers Conference.

H. B. Parks,
San Antonio, Texas.

Notes on Medical Entomology

F. C. Bishopp, Bureau of Entomology, visited Gibson Island, in the upper Chesapeake Bay, on July 5 to look into the problem of ticks and chiggers, which are seriously annoying residents there.

Dr. W. V. King, Bureau of Entomology, who spent most of July in Portland, Oregon, on business relating to the mosquito project, left there for his official headquarters at Mound, La., July 26.

R. W. Wells, Bureau of Entomology, of the field laboratory at Galesburg, Ill., is temporarily located at the field laboratory at Beltsville, Md., where he is conducting tests of electrified screens for the control of house flies.

F. C. Bishopp, Bureau of Entomology, spent the entire month of August in field travel. He made stops at the field laboratories at Galesburg, Ill., Fargo, N. Dakota, and Portland, Oregon, and visited many intermediate points to make observations on insects injurious to livestock.

W. E. Dove, Bureau of Entomology, who has been placed in charge of investigations of the sand fly, with headquarters at Charleston, S. C., arrived there August 19 to take up his duties under the new assignment.

On July 17 F. C. Bishopp, Bureau of Entomology attended a conference of physicians and health officers concerning the recently reported cases of typhus fever in Maryland. Much interest was shown in the likelihood of transmission of the disease through the agency of insects and ticks.

E. G. Green, of Natal, Rio Grande de Norte, Brazil, called at the Bureau of Entomology about July 10 and discussed parasites of the pink bollworm, incidentally offering to cooperate in a further study of such parasites in Brazil, with a view to their ultimate importation into this country.

Mr. C. R. Twinn, accompanied by Mr. G. H. Fisk, both of the Entomological Bureau, visited the Montreal and Hemmingford districts, Que., June 23–27, in connection with mosquito investigations. Particular attention was paid to mosquitoes of the genera *Culex* and *Mansonia* in the St. Pierre swamp at Montreal, and to *Anopheles* and *Culex* in the extensive swamps occurring in the Hemmingford district.